MACHINERY'S
SHOP RECEIPTS

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Six Hundred Useful Receipts, Compositions and Formulas Selected from MACHINERY'S Columns and Republished in a Classified, Pocket-size Edition, in Response to Repeated Requests from Friends Throughout the Mechanical Field

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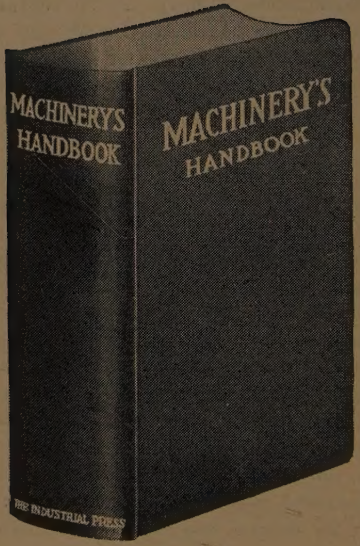
MACHINERY'S SHOP RECEIPTS

THIS book contains a large variety of special receipts, formulas, or compositions which have been used in various mechanical and other industries. Many of these receipts have proved valuable in making repairs, or in connection with the odd or unusual jobs that often prove so troublesome in mechanical work. Numerous other receipts in this collection have been utilized to advantage in manufacturing processes.

Practically all of these receipts have been collected from the columns of MACHINERY and they are republished here owing to the repeated demands for them. Frequently, several receipts or formulas have been given for the same purpose and it is evident that some must be superior to others. It is considered impracticable, however, to attempt the selection of the best receipt for a given purpose, because there are differences of opinion as to the relative merits in many instances, and frequently variations in working conditions affect the results obtained. It is important to note, however, that most of the receipts in this classified collection have been submitted to MACHINERY by men in the mechanical field who have had actual experience with the receipts recommended, and it is believed that all are practicable and effective for the purposes mentioned if the solutions or compounds are properly prepared and applied. If the experiments of any user should indicate that a receipt is unsatisfactory or does not meet the requirements fully, the publishers would appreciate knowing about it, as such information will be very helpful in revising future editions of this book.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ALLOYS

When two metals are melted together to form an alloy, the substance formed is, for all practical purposes, a new metal. Its appearance is different from that of the two or more original metals, and its properties, in general, are entirely different. Sometimes the alloy is harder than either of the ingredients. As an example may be mentioned brass, which is much harder than either the copper or zinc from which it is made. Alloys may be divided into ferrous and non-ferrous; the former contain iron as their chief component, while the latter do not. The compositions which follow are all in the non-ferrous class.

Free-cutting Brass Rod

The composition of normal free-cutting brass rod, according to the Bridgeport Brass Co., is: Copper, 61.50 per cent; lead, 3.00 per cent; zinc or spelter, 35.50 per cent. Iron should be kept as low as possible. In any event, it should not exceed 0.15 per cent. All impurities, including iron, should not exceed 0.25 per cent.

Free-cutting Brass Castings

A free-cutting brass having good casting and finishing properties, may be obtained by using the Society of Automotive Engineers, Inc. (S. A. E.) standard Specification No. 40. The composition in percentages follows: Copper, 83.00 to 86.00; tin, 4.50 to 5.50; lead, 4.50 to 5.50; zinc, 4.50 to 5.50; iron, maximum, 0.35; antimony, maximum, 0.25; aluminum, none. Castings made of this alloy should have a minimum ulti-

mate strength of 27,000 pounds per square inch. This is known as red brass.

Standard Yellow Brass Composition

The S. A. E. standard Specification (No. 41) for yellow brass is as follows, composition being in percentages: Copper, 62.00 to 65.00; lead, 2.00 to 4.00; zinc, 31.00 to 36.00; tin, maximum, 1.00; iron, maximum, 0.50; aluminum, none; other impurities, 0.25. This alloy is intended for commercial castings where cheapness and good machining properties are the main considerations. The minimum ultimate strength should be 25,000 pounds per square inch.

White Nickel Brass

A brass known as white nickel brass and intended for automobile trimmings or other parts requiring a metallic white finish is covered by S. A. E. standard Specification No. 42. Composition in percentages: Copper, 55.00 to 64.00; nickel, minimum, 18.00; iron, maximum, 0.35; aluminum, none; other impurities, 0.25; zinc, remainder. The higher the nickel content the more permanent will be the color. Good castings made of this alloy should have a minimum ultimate strength of 30,000 pounds per square inch.

Miscellaneous Brass Compositions

The following compositions for brass have been in use in a brass rolling mill:

High brass: 61.5 per cent of copper; 38.5 per cent of zinc.

Yellow metal: 60 per cent of copper; 40 per cent of zinc.

Cartridge brass: 66.7 per cent of copper; 33.3 per cent of zinc.

Low brass: 80 per cent of copper; 20 per cent of zinc.

Clock brass: about 60 per cent of copper and 40 per cent of zinc, with a small percentage (not exceeding 1.5 per cent) of lead.

Spring brass: about 66 per cent of copper and 33 per cent of zinc, with a small percentage (about 1.5 per cent) of tin.

German silver: 61.5 per cent of copper; 20.5 per cent of zinc; 18 per cent of nickel.

Brass wire is generally composed of from 63 to 67 per cent of copper and from 33 to 37 per cent of zinc. The tensile strength ranges from 40,000 to 80,000 pounds per square inch, increasing with the percentage of zinc in the alloy.

Bronze Compositions

Bronze is an alloy composed mainly of copper and tin in variable proportions, and sometimes containing small percentages of zinc, antimony, lead, aluminum, phosphorus, or manganese. Some phosphor-bronzes contain from 85 to 95 per cent of copper, from 5 to 10 per cent of tin, with a maximum of 4 per cent of zinc, 0.2 per cent of lead, 0.06 per cent of iron, and 0.15 per cent of phosphorus.

Manganese-bronzes usually contain from 57 to 60 per cent of copper, from 0.5 to 0.75 per cent of tin, from 37 to 40 per cent of zinc, 1 per cent of iron, and 0.30 per cent of manganese (and sometimes 0.5 per cent of aluminum). The name "manganese-bronze" is a misnomer, because the alloy consists mainly of copper and zinc and is actually a brass.

Gun bronzes consist of from 87 to 89 per cent of copper, from 9 to 11 per cent of tin, from 1 to 3 per cent of zinc, and a maximum of 0.06 per cent of iron and 0.2 per cent of lead.

Bell metal is a bronze containing 80 per cent of copper and 20 per cent of tin, and the metal used for Chinese gongs is a bronze of similar composition. The name "bronze" is also used for alloys with copper and various other metals, even when these alloys are nearly or entirely lacking in tin; thus, for example, aluminum bronze is mainly an alloy of copper and aluminum.

Standard Phosphor Bronze

This bronze alloy is an excellent composition for use where anti-friction qualities are desired, and it will withstand very well heavy loads and severe usage. Composition in percentages: Copper, 78.50 to 81.50; tin, 9.00 to 11.00; lead, 9.00 to 11.00; phosphorus, 0.05 to 0.25; zinc, maximum, 0.75; other impurities, maximum, 0.25. This is the Society of Automotive Engineers standard Specification No. 64. Good castings made of this alloy should have a minimum ultimate strength of 25,000 pounds per square inch.

Bronze for Gears and Worm-wheels

The Society of Automotive Engineers standard composition, in percentages, for phosphor gear bronze (Specification No. 65) is as follows: Copper, 88.00 to 90.00; tin, 10.00 to 12.00; phosphorus, 0.10 to 0.30; lead, zinc and other impurities, maximum, 0.50.

This is a very hard bronze and may be used for gears and worm-wheels where the requirements are

severe. Castings made of this alloy should have a minimum ultimate strength of 35,000 pounds per square inch.

Cast Aluminum Bronze

Cast aluminum bronze (S. A. E. Specification No. 68) is suitable for worm-wheels, gears, and similar parts. This is a non-corrodible alloy of great strength and with a hardness equal to that of manganese-bronze. Composition in percentages: Copper, 85.00 to 87.00; aluminum, 7.00 to 9.00; iron, 2.50 to 4.50; tin (none desired), maximum, 0.50; other impurities, maximum, 0.25.

High Copper Alloys

So-called "pure copper" castings ordinarily contain from one to three per cent of zinc. These are used in electrical installations and for die-blocks on electric welding machines. The conductivity, as compared with silver = 100, is not more than 60 per cent. Pure commercial copper containing from 99.6 to 99.9 per cent of metallic copper has a conductivity from 70 to 85 per cent of that of pure silver. Hence, the impurities in ordinary copper castings decrease, to a very great extent, its value as an an electrical conductor.

Silver-white Copper Alloy

A white metal alloy of high luster, capable of taking a brilliant polish and closely resembling silver in appearance, consists of 70 per cent copper, 15 per cent nickel, 9 per cent zinc, 4.3 per cent tin, and 1.7 per cent lead. The alloy is made as follows: The nickel is first melted with a flux of silica, and

half of the copper is added gradually and mixed, after which the remainder of copper is added. The zinc is then quickly plunged beneath the surface of the molten metal, which is stirred rapidly until the whole is melted. The lead and tin are added last while liquid. The metal is stirred and brought to a temperature of about 1700 degrees F., after which it is poured into ingot molds.

Rust-resisting Alloy

A composition used for typewriter levers consists of copper, 57 per cent; nickel, 20 per cent; zinc, 20 per cent; and aluminum, 3 per cent. Parts made from this composition, even when the nickel on the surface is worn off, never rust. The alloy is very hard, but may be bent to a considerable extent without breaking.

Name Plate Alloy

The following mixture has been found excellent for bronze name plates: Copper, 90 per cent; tin, 6 per cent; zinc, 2.5 per cent; lead, 1.5 per cent. If the lead is left out the bronze will usually dip better, but when any machine work is to be done upon the name plates, lead is added.

Babbitt Metal Composition

The exact composition of the original babbitt metal is not known. The ingredients were copper, tin, and antimony, in approximately the following proportions: 89.3 per cent tin; 3.6 per cent copper; 7.1 per cent antimony. This metal has great anti-frictional qualities, but the high percentage of tin makes it expensive and has led to the substitution of other

metals which are marketed under the name of "babbitt metal." These cheaper grades, when properly made, are superior to the original babbitt metal for some purposes.

The composition of babbitt metal should be varied according to the pressure to which it is subjected and the speed of the rotating member; the size of the bearing and thickness of the babbitt metal lining should also be considered. While it is not necessary to use a different composition for each slight variation, a different grade is preferable when the conditions are radically different.

Babbitt Metal for Heavy Pressures

The composition that follows gives a rather hard babbitt metal which may be used for lining connecting-rod and shaft bearings subjected to heavy pressures. This composition conforms to the S. A. E. standard specifications for No. 11 babbitt, and is suitable for die-castings.

Cast Products: Tin, minimum, 86 per cent; copper, 5 to 6.5 per cent; antimony, 6 to 7.5 per cent; lead, maximum, 0.35 per cent; iron, maximum, 0.08 per cent; arsenic, maximum, 0.10 per cent; bismuth, maximum, 0.08 per cent; zinc and aluminum, none.

Ingots: Tin, minimum, 87.25 per cent; copper, 5.5 to 6 per cent; antimony, 6.5 to 7 per cent; lead, maximum, 0.35 per cent; iron, maximum, 0.08 per cent; arsenic, maximum, 0.10 per cent; bismuth, maximum, 0.08 per cent; zinc and aluminum, none.

Cheap Babbitt Metal

The S. A. E. standard Specification No. 14 for babbitt metal provides a cheap babbitt that is in-

tended for large bearings and light service. This metal, however, should not be used as a substitute for a babbitt with a high tin content. It is suitable for die-castings. The composition in percentages is as follows: Cast products: Tin, 9.25 to 10.75; antimony, 14.00 to 16.00; lead, maximum, 76.00; copper, 0.50; arsenic, maximum, 0.20; zinc and aluminum, none.

Ingots: Tin, 9.75 to 10.25; antimony, 14.75 to 15.25; lead, maximum, 75.25; copper, 0.50; arsenic, maximum, 0.20; zinc and aluminum, none.

How to Babbitt Bearings

The important points connected with the babbitting of bearings are as follows: Choose a good, properly blended alloy made from pure metals, melt it slowly, thoroughly, and without overheating, and keep it at a constant temperature while working; have the surfaces of the shell dry and clean; warm them to the proper temperature, and, if of bronze, tin them as well; have the mandrel correctly leveled, lined, and centered, and likewise at the proper temperature; stir the metal thoroughly, before pouring, and dip it from the bottom of the pot, pouring evenly and steadily, without surging, splashing, or pocketing air; machine, peen, scrape, and fit the bearing accurately to the journal; have oil-holes open, oil-grooves clear, and surfaces free from sand, dirt, or babbitt chips.

Temperature of Babbitt and Mandrels

Babbitt metal used for bearings is melted in iron pots or kettles, and the molten metal should be kept at a constant temperature of about 870 degrees F.

The mandrels should be preheated to a temperature of from 200 to 300 degrees F. when pouring babbitt into the shells, but, for bronze shells, a somewhat lower temperature should be used. After the first few bearings are poured, it will become necessary to plunge the mandrels into water each time to reduce their temperature to the proper value. Oil-holes in the bearing shells are filled with asbestos or wood driven against the mandrel, and the joints are made tight with clay.

All iron shells must be preheated to a temperature of from 200 to 300 degrees F. before pouring the babbitt. The higher temperature is preferable, as a rule, except where a lining is being poured in a very heavy shell, when it may be necessary to use the lower temperature to prevent slow cooling.

Aluminum Alloy for Automotive Parts

The S. A. E. standard aluminum alloy (Specification No. 30) is now used more extensively in the automotive industry than all other light casting alloys combined. The composition in percentages follows: Aluminum, minimum, 90.00; copper, 7.00 to 8.50; zinc, maximum, 0.20; silicon, iron, zinc, manganese and tin, maximum, 1.70; other impurities, none.

This alloy has a specific gravity of about 2.83, and a tensile strength of 18,000 to 20,000 pounds per square inch for test specimens about 1/2 inch in diameter, cast in sand and tested without removing the outer skin. A shrinkage of 5/32 inch per foot should be allowed in pattern designs. This alloy is used for crankcases, oil-pans, steering-wheel spiders, differential carriers, transmission cases, camshaft housings, hub caps, and similar parts.

Aluminum Alloy for Pistons

The following aluminum alloy, which is the S. A. E. standard Specification No. 34, is used principally for automobile engine pistons, camshaft bearings, valve tappet guides, and other parts requiring high hardness and good bearing qualities. Composition in percentages: Aluminum, minimum, 87.00; copper, 9.25 to 10.75; iron, 0.90 to 1.50; magnesium, 0.15 to 0.35; all other elements, not over 0.75. This alloy is cast in permanent molds; test bars cast in a chill mold have a tensile strength of from 24,000 to 30,000 pounds per square inch. Specific gravity not over 2.95.

Aluminum Alloy for Thin Castings

S. A. E. standard Specification No. 35 provides an alloy intended for automobile body parts and other parts that must be cast in thin sections. Composition in percentages: Aluminum, minimum, 92.50; copper, maximum, 0.60; iron, maximum, 1.00; silicon, 4.50 to 6.50; zinc, maximum, 0.20; manganese, maximum, 0.20.

This alloy withstands salt water corrosion very well and is suitable for aircraft engine parts that may be subjected to severe corroding influences. It has a relatively low yield point and should not be used where great strength or stiffness is required. The minimum tensile strength of test specimens about 1/2 inch in diameter, cast in sand and tested without removing the skin, should be about 16,000 pounds per square inch.

Aluminum Brass

This alloy consists of 70.5 per cent of copper; 26.4 per cent of zinc; and 3.1 per cent of aluminum. It

is used in cases where an accurately sized casting is required. The alloy can also be rolled and forged hot, when the aluminum content does not exceed that specified. In aluminum brasses where the percentage of aluminum exceeds 4 per cent, it cannot be easily worked. The tensile strength of aluminum brass is about 42,000 pounds per square inch, with an elastic limit of about 17,000 pounds per square inch, and an elongation of 50 per cent.

Alloy for Pattern Letters and Figures

A good alloy for casting pattern letters and figures and similar small parts in brass, iron or plaster molds is made of lead, 80 parts, and antimony, 20 parts. A better alloy would be lead, 70 parts; antimony and bismuth, each 15 parts. To insure perfect work, the molds should be quite hot; heat by placing over a Bunsen burner. The writer has had thousands of pattern letters and figures made in this manner. OSCAR E. PERRIGO.

Acid-resisting Alloy

The following alloy is claimed to possess exceptional qualities with regard to its ability to resist the action of acids: Nickel, 66.6 per cent; chromium, 18 per cent; copper, 8.5 per cent; tungsten, 3.3 per cent; aluminum, 2 per cent; manganese, 1 per cent; titanium, 0.2 per cent; boron, 0.2 per cent, and lithium, 0.2 per cent. This alloy is difficult to cast because it contracts considerably at the point of solidification. It can be drawn into wire and is easy to work.

CEMENTS FOR BELTING

Two kinds of cement are used for joining the ends or plies of leather belting to produce what is generally termed an endless belt. One kind is referred to as "regular" belting cement and the other kind as "waterproof" belting cement. Both kinds can be obtained from the leather belting manufacturer, and either has ample strength and durability. When a belt is to be used in a dry place, where it is not subjected to moisture, the regular belting cement is employed, while the waterproof cement is used in damp places and where the belt comes in contact with water.

Preparation of Belt Cement

The regular cement usually comes in cakes or lumps, which are dissolved in water in a double-jacketed glue pot. Any pot with a double jacket—that is, with an inner and an outer vessel, so that the heat reaches the cement through the medium of hot water, and not directly from the flame, will serve the purpose, though it is better to use the Safety or Underwriter's glue pot, for in it the glue may be maintained under heat directly at the job, and without risk of causing fire.

The cement should be made hot, but it should not be permitted to boil. It should be reduced with hot water to a proper consistency to spread easily, and must be applied "piping" hot, to get the best results. It is desirable, too, that it should be applied fresh, and it is better not to attempt to use over the remains of a previous melting, if it is old and hard. The pot and the brushes must be kept clean, as the base of this cement, animal glue, is subject to putrefaction.

Waterproof Belting Cement

The waterproof cement is essentially a liquid celluloid and its application places a layer of celluloid between the two surfaces of the lap, in which the leather fibers become embedded. It is unaffected by water, in any period of time, because both its base and its solvent are materials that are not soluble in water. It should be used on all belts that are exposed to damp conditions, or on which water may leak.

The solvent is very volatile, and highly inflammable, and it must be kept away from any open light. This cement is in a liquid form. Usually it is ready to spread, though after some spreading the remainder will grow thicker and should be reduced by the addition of solvent, which can be obtained from the same source as the cement. This cement is more like a varnish, and it is used cold.

Application of Waterproof Cement

The surface to be cemented must be thoroughly coated with the cement, well brushed into the fibers of the leather, and then permitted to dry, which, because of the volatility of the solvent, takes place rapidly. When dry, another coat is applied. This coat is spread lightly and is also permitted to dry. When the second coat is perfectly dry, the belt is ready for the third and last coat. Care must be taken to apply the cement evenly and not leave any bare spots.

On belts wider than 12 inches, it is best not to attempt to cover more than a 5-inch cross-section of the belt at one time, since the solvent evaporates very fast, and it is easier to handle a small surface.

When applying the last coat, the work must be done quickly. The joint should not be hammered, but rubbed gently or placed between boards, and pressure applied with the bench screws. The joint should "set" for a couple of hours or longer before using the belt. L. W. ARNY.

Belt Cement—1

To prepare a good cement for leather belts, soften equal parts of good hide-glue and American isinglass, in warm water for about ten hours. Mix the two ingredients together thoroughly and then pour on a quantity of pure tannin and boil until the mass is sticky. Just enough tannin should be added so that the mass will have a good consistency when boiling hot. To apply the cement, roughen the surfaces to be cemented and apply the cement while it is very hot. Press the parts together firmly and hold in that position until dry. T. E. O'DONNELL.

Belt Cement—2

To make a cement for leather belts use gutta-percha, 16 parts; pure white India rubber, 4 parts; dissolve, and then add pitch, 2 parts; shellac, 1 part; and boiled linseed oil, 2 parts. W. R. BOWERS.

Belt Cement—3

To make a reliable belt cement use 1 pound of Peter Cooper's white glue and 1 ounce of powdered white lead; mix like ordinary glue (thick). When used it should be thinned to the required consistency with grain alcohol and applied hot. This cement is particularly valuable where long, hard usage is required, such as for dynamo belts. J. H. V.

Belt Cement—4

Mix 5 ounces bisulphite of carbon with 1/2 ounce spirits of turpentine, and enough gutta-percha to make a paste. Thin the ends of the belt so that when they are joined the thickness at the joint is the same as the thickness of the belt. If the belt ends are greasy, apply some blotting paper and a hot iron to free them from grease. Then apply some of the paste, and press the parts together, using screw clamps and two pieces of board of the same width as the belt. The cement will dry in a short time, when the clamps can be removed. J. M. Menegus.

Belt Cement—5

In an ordinary glue pot soak overnight a pound of good fish glue in a pint of cold water. Heat this, stirring until completely dissolved. Then add one ounce of dry white lead. When the mixture has been again thoroughly stirred and is nearly cool, add one ounce of grain alcohol, and stir it well in. Heat the cement again when it is wanted for use. In the use of this cement care should be taken to have the laps freshly and smoothly cut, and as clean as possible. The cement should be evenly spread with a brush over both surfaces and the surfaces placed in contact as quickly as possible, and on each side of the lapped belt should be placed a previously warmed board and the whole clamped together for an hour or two, according to the width of the belt, its thickness and the amount of strain it will have to stand. This cement can be made in larger quantities by using the same proportions, and when cool it may be cut up into small pieces and kept in good condition in a fruit jar tightly closed. Oscar E. Perrigo.

CEMENTS FOR CASTINGS

Some castings that are porous or defective because of blow-holes may be made serviceable by using a filler or cement. Some of the mixtures which follow are intended for filling porous places and others are preferable for larger holes or cavities.

Filler for Porous Casting—1

One part red lead, and 1 1/2 parts litharge mixed with glycerin to consistency desired may be used as a filler. E. H. McClintock.

Filler for Porous Casting—2

Use one-quarter tumbler full of japan dryer, 1 1/2 ounces finely ground dry white lead. Mix and add 1 quart of finishing japan. Stir in dry rotten stone until mixture is a thick paste. E. H. McClintock.

Filler for Porous Casting—3

To make a porous casting air and water tight prepare a saturated solution of copper sulphate, mix with it an equal quantity of commercial nitric acid. Dip the casting into the solution, or pour it over the casting on all sides and let stand for a few hours.

L. S. Burbank.

Filler for Porous Casting—4

A filler for holes and cracks in castings is made of 6 parts red lead, ground in oil; 3 parts white lead, ground in oil; 2 parts black oxide of manganese; 1 part silicate of soda; 1/2 part litharge. Mix and use as a putty. To preserve from hardening, put in a vessel and cover with water. C. E. Mink.

Cement for Defective Castings—1

For plugging holes in castings a good cement is made from 80 parts of sifted cast-iron turnings, 2 parts of powdered sal-ammoniac, and 1 part sulphur, made into thick paste with water fresh for use.

DAVID MELVILLE.

Cement for Defective Castings—2

Mix 1 pound cast-iron filings, 1 ounce sulphur, and 2 ounces sal-ammoniac. Mix thoroughly and keep dry. When using, mix one part of this composition with twenty parts clear filings and some very fine sand. Make into a stiff paste with water.

E. H. MCCLINTOCK.

Cement for Defective Castings—3

The following mixture has been successfully used in filling cracks in gas engine water jackets, and is similar in nature to the ordinary rust joint mixtures. Prepare a dry mixture of 17 parts of cast-iron filings, 2 parts of sal-ammoniac, and 1 part of flour of sulphur; add twenty times the weight of new iron filings, put in a mortar and add water so as to obtain a paste. This paste is applied to the crack, and in a short time becomes as hard as the metal itself.

M. E. CANEK.

Cement for Defective Castings—4

A good mixture for plugging blow-holes in cast iron is made of sulphur, cast-iron borings sifted very fine, and graphite. Melt the sulphur in an iron ladle and stir in as much of the sifted borings as the sulphur will allow, not making it too thick to pour readily. Add a small quantity of the graphite, say a

tablespoonful to a quart of the mixture. Pour into the holes while hot, and after it is cool smooth off with a file.

R. B. CASEY.

Cement for Defective Castings—5

The following formula for filling defects and blowholes in castings has been used for years and it is the result of many experiments: 1 1/2 parts litharge; 2 1/2 parts dextrin; 4 parts iron borings or turnings, carefully sifted. Mix the parts well, add water until the mass is of about the consistency of mortar. With a putty knife or other implement fill the defective parts and press into every crevice. Let it "set" for 48 hours, when it can be chipped, planed, bored or turned like the casting itself. Color with lampblack to suit the shade of casting.

W. W. BIRNSTOCK.

Cement for Defective Castings—6

The following is a good mixture for a cement for filling holes in cast iron; Powdered cast iron, 40 parts; powdered sal-ammoniac, 1 part; powdered sulphur, 1/2 part. These ingredients are thoroughly mixed together and placed in an air-tight receptacle in a perfectly dry condition until wanted. When a hole in a casting is to be filled, take what appears to be the required quantity of the mixed powder, moisten it with water to the consistency of paste or putty, and fill the hole or depression, smoothing it up and allowing it to set.

When very deep depressions are to be filled, add to the above mixture an equal weight of fresh "vulcanite" Portland cement before dampening. After the water has been added, so that the mixture has the

desired consistency, add non-volatile oil to the extent of 8 per cent, by weight, of the dry mixture used, and work the mass until the oil is fully emulsified; then apply the paste, finishing with a facing of the original mixture containing no Portland cement. This will produce a filler which will not shrink in setting.

C. H. CASEBOLT.

Alloy for Filling Holes in Cast Iron

Melt together 9 parts of lead, 2 parts of antimony, and 1 part of bismuth, and pour this mixture into the hole, first somewhat warming the hole. This alloy possesses the quality of expanding when cooling, hence, becomes solid in the holes when cold.

E. J. BUCHET.

Amalgam for Leaks and Blow-holes

A small hole or crack that is difficult to get at or that cannot well be soldered may be closed with an amalgam composed of zinc, 66 parts; tin, 44 parts; and sufficient mercury to make a stiff dough. The zinc and tin are to be melted together and afterward granulated. The latter may be done by slowly pouring the melted mixture through a strong stream of water from a hose nozzle; or the filings may be used. The filings or granules are kneaded until an amalgam of the consistency of stiff dough is formed with the mercury. Excess of mercury should be squeezed out. The plastic mass is then forced into the opening and allowed to harden for an hour or two. It can then be filed and scraped like the metal itself. Only as much amalgam should be mixed as is required for immediate use.

O. M. BECKER.

CEMENTS FOR JOINTS

A strong cement which is oil-proof, waterproof, and acid-proof, consists of a stiff paste of glycerin and litharge. These form a chemical combination which sets in a few minutes. If a little water is added, it sets more slowly, which is often an advantage. This cement is mixed when required for use.

Red Lead Mixture for Threaded Pipe Joints

A good material to apply to pipe threads before making up the joints, in order to obtain a tight joint that will resist the action of gases or liquids, is made of red lead mixed with pure boiled linseed oil. This mixture has been widely used and is very satisfactory. It should have a heavy fluid-like consistency, and if applied to a clean, well-cut thread will give an excellent joint.

Shellac for Pipe Connections

Shellac has proved to be a very satisfactory substitute for lead in sealing air and gas pipe connections. It is applied with a brush to the joints and hardens very rapidly, and being brittle, the pipes can be readily disconnected. S. C. S.

Graphite, Litharge, Chalk Cement

A good cement for use in making steam pipe joints is made in the following manner: Grind and wash in clean cold water 15 parts of chalk and 50 parts of graphite; mix the two together thoroughly and allow to dry. When dry regrind to a fine powder, to which add 20 parts of ground litharge and mix to a stiff

paste with 15 parts of boiled linseed oil. The preparation may be set aside for future use, as it will remain plastic for a long time if placed in a cool place. It is applied to the joint packing as any ordinary cement and will be found to last a very long time.

T. E. O'DONNELL.

Sulphur, Graphite, Lime Cement

To make cement for steam, air and gas pipes, mix thoroughly powdered graphite, 6 parts; slaked lime, 3 parts; sulphur, 8 parts, and boiled oil, 7 parts. The mixture must be thoroughly incorporated by protracted kneading until it is perfectly smooth and free from lumps.

O. E. VORIS.

White and Red Lead Mixture

Take ordinary white lead, and mix enough powdered red lead with it to make a paste the consistency of putty. Spread this mixture on the joint, and when it hardens, the joint will be perfectly water tight. We used this mixture on flanges on a standpipe, after we had tried all kinds of rubber gaskets without success. The mixture hardened and made a tight joint, never leaking afterward.

J. D. PAGE.

Steam-tight Joints

Take white lead ground in oil, add to it as much black oxide of manganese as possible and a small portion of litharge. Knead with the hand, dusting the board with red lead. The mass is made into a small roll and screwed or pressed into position, the joint being first slightly oiled with linseed oil.

R. E. VERSE.

Cement for Steam and Water Pipes

A good cement for joints on steam or water pipes is made as follows: 10 pounds fine yellow ochre; 4 pounds ground litharge; 4 pounds paris white (whiting), and 1/2 pound of hemp cut up fine. Mix together thoroughly with linseed oil, to about the consistency of putty. R. M.

Substitute for Red Lead

As a substitute for, or in the absence of red lead, use varnish on air or steam pipe joints. It will dry very hard and last for a long time.

DONALD A. HAMSON.

Mixture for Rust Joint

Mix 10 parts of iron filings, 3 parts chloride of lime with enough water to make a paste. Apply this mixture to the joint, bolt firmly together and in twelve hours it will set. DAVID MELVILLE.

Permanent Cement for Steam Pipes

To make a permanent cement used for stopping leaks in steam pipes where calking or plugging is impossible, mix black oxide of manganese and raw linseed oil, using enough oil with the manganese to bring it to a thick paste; apply to the pipe or joint at leak. It is best to remove pressure from the pipe and keep it sufficiently warm to absorb the oil from the manganese. In twenty-four hours the cement will be as hard as the iron pipe. JAMES H. TAYLOR.

High-pressure Water Pipes

A highly recommended packing and cement, combined, for making tight joints in high-pressure water

pipes, is made as follows: Mix with boiled linseed oil, to the consistency of putty, these ingredients: Ground litharge, 10 pounds; plaster of paris, 4 pounds; yellow ochre, 1/2 pound; red lead, 2 pounds; cut hemp fiber, 1/2 ounce. The hemp fiber should be cut in lengths of about 1/2 inch, and thoroughly mixed into the putty material. Its office is to give consistency to the cement. The cement is applied to the joint similarly to any other cement. It dries thoroughly in from 10 to 12 hours. T. E. O'DONNELL.

Lubricating Mixture for Pipe Threads

A good mixture for making pipe connections, is composed of 1 pint of "black strap" machine oil, 1/2 pint graphite, 1/4 pint of white lead, and a teaspoonful of flour emery. These proportions are not exact, but they are substantially what are used. The object of the flour emery is to polish the threads as they are being screwed together. The graphite, white lead and oil make a fine lubricating mixture, which has enough consistency to stop incipient leaks. The writer has seen many large pipe radiators made up using this mixture, and they never leaked when the steam was turned on. M. E. CANEK.

Packing to Resist Gasoline Vapor

To prepare packing for joints in pipes, etc., carrying gasoline vapor, mix a quantity of graphite and kerosene to a thick paste and apply the paste to both sides of sheet asbestos. When dry, the packing may be cut to the shape desired. The graphite helps the asbestos to make intimate contact with the iron and thus maintain a tight joint continuously at high temperature for an idefinite time. H. J. BACHMANN.

Mixtures for Plug Cocks and Glass Stoppers

To make an anti-leak and lubricating mixture for plug cocks, use 2 parts of tried suet and 1 part of beeswax melted together; stir thoroughly, strain and cool.

A mixture for making glass stoppers tight is made by melting together equal parts of glycerin and paraffin. L. S. Burbank.

Cement to Resist Acids

A cement that withstands hydrochloric acid vapors consists of rosin, 1 part; sulphur, 1 part; fireclay, 2 parts. A cement composed of boiled linseed oil and fire clay acts well with most acid vapors. A composition of glycerin and litharge is useful in this connection, especially when made up according to the following formula: Litharge, 80 pounds; red lead, 8 pounds; "flock" asbestos, 10 pounds. It should be fed into a mixer, a little at a time, with small quantities of boiled oil (about six quarts of oil being used). Sockets in 3-inch pipes carrying nitric acid, calked with this preparation, showed no leaks in nine months.

Cements for Machine Joints

The following are cements used to make the joints of machinery air and water tight:

1. Mix ground white lead with one-fourth its weight of red lead.

2. Mix equal parts of red lead and white lead, in powdered form, with enough boiled linseed oil to make the whole a soft, putty-like mass.

3. To 50 pounds of borings, preferably cast iron, which have been pounded and sifted, add one pound

of sal-ammoniac. Mix with water when ready to use.

4. Boiled linseed oil and red lead mixed to the consistency required. A small quantity of litharge improves the cement for many purposes.

5. Cast-iron borings, 4 pounds; dried potter's clay, 1 pound; powdered potsherds (broken crockery), 1 pound. Make into a paste with salt and water.

No. 3 is used largely for filling cracks in boilers, etc., and No. 5 is excellent for outdoor iron work, water tanks, etc.

F. L. Engel.

CEMENTS FOR METALS

A very good cement for cementing metal parts consists of the following ingredients: 2 1/2 parts zinc oxide; 1 part zinc chloride; 5 parts pulverized limestone, slag, etc. Mix to a thick paste, using water. If the cement is wanted to set slowly, add 1 part of zinc sulphate instead of 1 part of zinc chloride. The adhesive power of this cement can be increased by adding 2 per cent of ferrous sulphate to the whole.

HERBERT S. GLADFELTER.

Cement for Iron and Steel—1

Use a compound consisting of sulphur, 6 parts; white lead, 6 parts; and borax, 1 part. These substances are dissolved in concentrated sulphuric acid, and the surfaces to be united covered with the mastic, and pressed very hard together. In about six days the two pieces are so well joined that even hammering will not part them. J. M. MENEGUS.

Cement for Iron and Steel—2

The following cement, if properly prepared and applied, will unite broken iron or steel parts very strongly, and may be found useful oftentimes for repairing broken machine parts of comparative unimportance. Mix thoroughly equal parts of sulphur and white lead with about one-sixth part of borax. When ready to use the mixture, wet it with strong sulphuric acid and spread a thin layer of the cement on the joint to be united. Clamp together for five days, when the joint should be dry and sound.

J. W. WILFORD.

To Unite Metals of Any Kind

The following mastic may be used to unite metals of any kind. It becomes very hard. First, mix well together 4 parts of iron filings with 4 parts of chloride of ammonia. Then dissolve 100 parts of arabic gum and 20 parts of sugar in 100 parts of water, and add 1 1/2 parts of nitric acid. Boil this, and put the first mixture into it. When the mastic has to be used, mix one part of it with ten parts of new iron filings and some water, and heat it until a paste is formed, which is applied, well heated, to the pieces to be united. J. M. MENEGUS.

To Fasten Paper to Iron or Steel

Rub the surface over with an onion cut in half. Then apply the label with glue or paste.

L. E. MUNCY.

Attaching Cloth to Iron

Heat the iron so it will be just too hot to touch with the bare hand, put on a coat of red shellac; have the cloth already cut, applying it quickly, and press firmly in place. JAMES A. PRATT.

Cement for Leather and Iron—1

To face a cast-iron pulley with leather, apply acetic acid to the face of the pulley with a brush, which will roughen it by rusting; and then, when dry, apply a cement made of one pound of fish glue, and 1/2 pound of common glue, melted in a mixture of alcohol and water. The leather should then be placed on the pulley and dried under pressure. R. M.

Cement for Leather and Iron—2

To make a good quality of glue for fastening leather to iron, as required when covering iron pulleys with leather, etc., the following will be found to be a good receipt: To one part of glue dissolved in strong cider vinegar add 1 ounce of Venice turpentine. Allow this to boil very slowly over a moderate fire for 10 to 12 hours. It should be applied to the surface of the iron, upon which the leather is to be cemented, with a brush, while it is still quite warm. Before applying, the iron surface and the leather should be scraped perfectly clean. Then put on the leather, press it firmly into place and allow ,to dry for a few hours. T. E. O'DONNELL.

Cement for Leather and Iron—3

Soak six pounds of carriage glue overnight; then heat until thoroughly dissolved and add six pounds of white lead ground in oil. Reduce the mixture with oil until it is of a free working consistency. Now add one ounce of nitric acid and stir until thoroughly mixed. The pulley surface should be made thoroughly clean and should be warmed to about 125 degrees F. Then apply the cement and clamp on the leather and let stand twelve hours before using. If the job is done right, the leather will have to be turned off in a lathe in order to remove it.

E. B. GAFKEY.

Cement for Leather and Iron—4

First soak twelve ounces of good glue in cold water. Put four ounces of boiled oil and four ounces of turpentine into the glue pot, and in this dissolve three ounces of rosin. When the rosin is dissolved,

add the glue. The rosin and glue should be well stirred while dissolving.

Before applying a leather cover to a pulley have the pulley warm and dry, and scrape off all matter that may have accumulated on its face. Then, with a swab, apply muriatic acid (full strength) to all parts of the face of the pulley. When dry, wipe gently with waste. Cut leather lengthwise of hide, and a little wider than the face of the pulley. Have the cement melted in the glue pot, apply it across the face of the pulley, with a brush, for about six or eight inches, lay on the end of leather and rub it down hard with the corner of a piece of wood. Fold back the leather and continue to apply cement until the pulley is covered. In applying two thicknesses of leather to a band-saw pulley, make the first thickness a butt joint, and the last a scarf or lap joint about three or four inches long. Make the laps on the driven pulleys the way they run, and on the drivers the opposite way. Pulleys should be cleaned by holding a piece of coarse sand paper against them.

R. F. WILLIAMS.

Cement for Soft Rubber and Metals

A cement which is effective for cementing rubber to iron and which is specially valuable for fastening rubber bands to band-saw wheels is made as follows: Powdered shellac, 1 part; strong water of ammonia, 10 parts. Put the shellac in the ammonia water and set away in a tightly closed jar for three or four weeks. In that time the mixture will become a perfectly liquid transparent mass and is then ready for use. When applied to rubber the ammonia softens it, but it quickly evaporates, leaving the rubber in the

same condition as before. The shellac clings to the iron and thus forms a firm bond between the iron and the rubber. M. E. Canek.

To Cover Pulleys with Rubber

Thoroughly clean the surface of the pulley; if the pulley has just been turned in the lathe, so much the better. Give it a thorough wash in muriatic acid and let stand overnight. In the morning give the iron and rubber a good coat of heavy yellow shellac varnish and apply the rubber and clamp. Let stand until thoroughly set. E. B. Gafkey.

To Glue Asbestos to Iron

One of the most reliable cements or glues to use for attaching asbestos or any other fabric to iron is silicate of soda. It is successfully used for attaching emery paper disks to disk grinders. It is particularly useful for attaching asbestos to furnace pipes, because it stands heat well, and for this reason silicate of soda is an all-round cement of much value.

M. E. Canek.

Cement Metals and Wood

Dissolve in boiling water 2 1/4 pounds glue, 2 ounces gum ammoniac, and, drop by drop, 2 ounces of sulphuric acid. W. R. Bowers.

Cement for Grinder Disks—1

We use silicate of soda (liquid glass) for fastening abrasive disks to a disk grinder, and think it is the best cement we ever tried. It requires no haste in applying, and the hotter the disk gets, the tighter it sticks. H. G. Herrick.

Cement for Grinder Disks—2

A good substitute in place of glue or various kinds of cement for fastening abrasive cloth to disk grinders is to heat or warm the disk and apply a thin coating of beeswax; then put the cloth in place and allow to set or cool under pressure. G. HUBER.

Cement for Grinder Disks—3

For disks of abrasive paper melt together 5 parts paraffin, 4 parts beeswax and 1 part rosin. When cold, cut into blocks, and apply evenly on the revolving disk until it has a thin coat over its entire surface. The abrasive paper should then be pressed in the disk while it is still revolving, thereby slightly heating both the disk and the paper, and causing the cement to spread in a thin layer all around the disk. The belt should then be shifted into the loose pulley, so that the paper may be pressed closely to the disk. The corners may then be trimmed off with an old file. It requires a little practice to perform the job successfully, but the method is much superior to removing the disk and gluing the paper on in a press. The worn-out paper can be more easily removed, it being only necessary to wait until the disk is cool, when, by taking hold of one portion of the paper, it may be ripped right off. H. J. BACHMANN.

Cementing Abrasive Cloth to Lapping-wheel

This mixture contains 4 1/2 pounds of rosin; 3 pounds of paraffin; 9 ounces of vaseline. Melt the ingredients and mix them thoroughly. Heat the surface of the lapping-wheel and spread on the mixture. Then rub the cloth down so as to exclude all air

from between the surface of wheel and cloth. The surface of the lapping-wheel should be clean before the cement is applied. J. H. CHEETHAM.

Leather Fillets on Brass Patterns

To cement leather fillets to brass patterns, melt together 8 parts pure beeswax and 2 parts rosin; cut into strips when cold and apply with a slicking tool of the proper radius. A piece of wire set into a steel ball, and heated over a Bunsen burner is the best for this purpose. The pattern should be slightly warmed to enable the cement to flow between the leather and brass. When cold, any superfluous cement may be removed with a piece of waste soaked in spirits of turpentine. H. J. BACHMANN.

Cement for Glass and Brass—1

A cement for fastening glass work to brass tubes is made of rosin, 5 ounces; beeswax, 1 ounce; and red ochre or venetian red, in powder, 1 ounce.

W. R. BOWERS.

Cement for Glass and Brass—2

It is often necessary, in electrical factories and repair shops, to cement small brass parts to glass. A good cement for this purpose is made from the following: 1 part caustic soda, 3 parts rosin, 3 parts plaster of paris, 5 parts water. Boil all the constituents together until thoroughly mixed, and then allow to cool before using. The cement hardens in half an hour. If it is desired that it should not harden so quickly, substitute zinc white, white lead, or slaked lime, for the plaster.

T. E. O'DONNELL.

Cement for Metal and Glass—1

To make a cement for attaching metal to glass mix 2 ounces thick glue, 1 ounce linseed oil, 1/2 ounce turpentine. Boil together for a short time, when it will be fit for use. Apply hot with a brush and clamp the parts together for about two days to allow the cement to dry. R. M. K.

Cement for Metal and Glass—2

Melt together in a water bath 15 parts of copal varnish, 5 parts of drying oil, and 3 parts of turpentine. When the ingredients are well mixed add 10 parts slaked lime. An elastic cement for fastening brass to glass may be made by mixing 5 ounces of rosin, 1 ounce beeswax, and 1 ounce of red ochre or venetian red in powdered form. Melt the rosin and beeswax together by gentle heat, and gradually stir in the venetian red. W. R. Bowers.

Glue for Sheet Mica and Steel—1

A mixture of gum and calomel forms one of the best adhesives for attaching mica to steel. It is prepared by putting the very best pure gum arabic into a small quantity of water, and allowing the mixture to stand overnight, after which it should have the consistency of treacle. Calomel (mercurous chloride or subchloride of mercury) is then added in sufficient quantity to form a sticky mass, which should be well mixed on a perfectly clean surface with a spatula. No more of the adhesive should be mixed than is required for immediate use. Although this adhesive hardens within a few hours, it is best not to disturb parts that have been joined by it for a day or two.

A. Eyles.

Glue for Sheet Mica and Steel—2

The following formula for rosin shellac has been used successfully for attaching mica, varnish, cambric, and other insulating materials to steel, cast iron, copper, or brass. It is necessary that the metal be thoroughly clean before the shellac is applied. First, "cut" some shellac with denatured alcohol, using enough shellac to form a heavy thick paste. Next make a solution of pulverized rosin and alcohol. Then heat the shellac, and mix equal parts of the two mixtures, stirring the materials thoroughly. The resulting rosin shellac should be applied cold.

O. J. Fink.

CEMENTS—MISCELLANEOUS

To make a cheap cement for general use, mix gum acacia (pulverized), 1 ounce; French insinglass, 2 ounces; vinegar, 4 ounces; essence of sassafras, 5 drops. After mixing allow it to stand for 12 hours, then heat until thoroughly dissolved, when it is ready for use. For covering pulleys with leather, paper, etc., add 1/2 ounce glycerin to one quart of cement, heat and use while hot. Oily belts can be successfully spliced with this cement by rubbing the scarfed ends with powdered sal soda and applying a coat of cement, which is allowed to dry; then apply a second coating and put together. J. H. V.

Fastening Tools in their Handles

A cement for fastening tools in their handles is made as follows: Mix one part beeswax, one quart fine brick dust and four parts black rosin.

E. H. McClintock.

Shellac Cement

Shellac is the basis of most adhesive cements. A good one is made by thickening shellac varnish (shellac dissolved in alcohol) with dry white lead, mixing the two with a putty knife on a piece of glass.

W. H. Sargent.

Portland-tar Cement

A valuable cement used in marine practice, and other places where elasticity is desirable, is made by mixing Portland cement in gas tar until the consistency is that of stiff putty. It must be applied immediately, as it quickly hardens. It is not affected

by water and never becomes brittle, a fact that makes it very valuable around the tail-shafts of steamers or wherever there is much vibration.

A. L. GRAFFAM.

Cement for Rubber Goods

Dissolve raw gum rubber or caoutchouc in bisulphide of carbon for a number of days in a tightly stoppered bottle until it has the consistency of a thick paste. Make the surfaces to be cemented clean and dry before applying, and press joint tightly together.

L. E. MUNCY.

Cement for Leather

One ounce shellac, 2 ounces pitch, 2 ounces linseed oil, 4 ounces caoutchouc, 1 pound gutta-percha. Melt together and apply hot. E. H. McCLINTOCK.

Acid-proof Cement

Mix a concentrated solution of soda with pulverized glass to form a paste, W. R. BOWERS.

Waterproof Cements

To make a good waterproof cement in a thin paste form, dissolve 1 ounce powdered rosin in 10 ounces strong ammonia and add 5 parts gelatin and 1 part solution of acid chromate of lime. For waterproof cement in paste form, add to hot starch paste one-half its weight of turpentine and a small piece of alum. T. E. O'DONNELL.

Cement Not Affected by Alcohol

Gold size is valuable as a cement for setting together parts of vessels containing alcohol, as it is

not affected by alcohol as are some other good cements. It has been used for setting the glass covers of circular levels, the glass afterwards being burred over in the brass shell so that it is securely held mechanically. Ordinary painters' size is used, which may be prepared as follows: Boil raw oil in a pan until it smokes, then set it on fire and let burn for a few moments. Cover the pan to extinguish the blaze and pour while warm into a receptacle containing red lead and litharge in the proportion of one ounce of each to a quart of oil. Keep at a temperature of 70 degrees for ten days and agitate once a day. M. E. CANEK.

Cement for Arc Lamp Carbons

The short ends of old arc lamp carbons may be cemented together to form rods which burn quite well, and are no more brittle than ordinary carbons. The cement required is made by mixing potassium silicate and carbon dust to a consistency of a thick paste. The ends of the short carbon pieces are faced off square, and, after application of the paste, are pressed together by hand. O. G.

To Fasten Rubber to Wood

Make a cement by macerating virgin gum rubber, or as pure rubber as can be had, cut in small pieces, in just enough naphtha or gasoline to cover it. Let it stand in a very tightly corked or sealed jar for fourteen days, or a sufficient time to become dissolved, shaking the mixture daily.

Another cement is made by dissolving pulverized gum shellac, 1 ounce, in 9 1/2 ounces of strong ammonia. OSCAR E. PERRIGO.

Gluing Emery to Wood or Metal

The following is a good receipt for gluing emery to wood or metal. Melt together equal parts of shellac, white rosin and carbolic acid (in crystals) adding the carbolic acid after the shellac and rosin have been melted. This makes a cement having great holding power. W. T.

Glycerin-litharge Cement

A handy cement to have in the shop for stopping leaks, etc., and which can be used for cementing glass, brass, etc., is made by mixing equal parts of litharge, commercial glycerin and Portland cement. This cement will harden under water and will withstand hydrocarbon vapors. O. E. Voris.

Waterproof Cements for Glass

Probably the simplest and best aquarium cement (the formula for which is recommended by the United States Fish Commission) is made as follows: Stir together by weight 8 parts pulverized putty (dry whiting), 1 part red lead and 1 part litharge. Mix as wanted for use with pure raw linseed oil to a consistency of stiff putty. Allow it to dry a week before using.

Another waterproof cement is made by dry mixing 10 parts each, by measure, of fine dry white sand, plaster of paris and litharge and 1 part powdered rosin. Mix as required to a stiff putty with boiled linseed oil. The linseed oil must be free from any trace of adulteration with fish oil. It is sometimes necessary to boil pure raw linseed oil a few moments to drive off the water. A. L. Graffam.

Cement for Switchboard Repairs

A good cement for making repairs on switchboards, when iron or other metal has to be fastened to marble, or where binding posts have been pulled out, may be made to consist of 30 parts plaster of paris, 10 parts iron filings, and 1/2 part of sal-ammoniac. These are mixed with acetic acid (vinegar) to form a thin paste. This cement must always be used immediately after being mixed, as it solidifies if allowed to stand for any length of time. It will be found to be an excellent means for filling up old binding-post holes, when instruments have been moved.

T. E. O'Donnell.

Cement for High Temperatures—1

A cement that will resist white heat may be made of pulverized fire clay, 4 parts; plumbago, 1 part; iron filings or borings free from oxide, 2 parts; peroxide of manganese, 1 part; borax, 1/2 part, and sea salt, 1/2 part. Mix these to a thick paste and use immediately. Heat up gradually when first using.

W. R. Bowers.

Cement for High Temperatures—2

To make a fire cement use 100 parts fire clay, wet; 3 parts black oxide manganese; 3 parts white sand; and 1/2 part powdered asbestos. Thoroughly mix, adding sufficient water to make a smooth mortar.

C. E. Mink.

Cement for High Temperatures—3

A fire clay mixture that will stand a high temperature without cracking or checking is mixed as

follows: 45 per cent crushed fire brick, 50 per cent fire clay, and 5 per cent clean, sharp sand. This is to be moistened and mixed to a heavy paste, tamped into the shape required and burned dry.

E. W. Bowen.

Cement for High Temperatures—4

As a binder for a cement to stand high heat (1475 degrees F.), use sodium silicate (water glass) diluted with rain water until a specific gravity of 20 degrees on the Baumé hydrometer is obtained. Sand or quartz may be used in the cement to give the proper consistency.

Clay Mixture for Forges

After repeated trials with various clay mixtures recommended for forges, we experimented until we discovered the eminently satisfactory one given in the following: 20 parts fire clay; 20 parts cast iron turnings; 1 part common salt; 1/2 part sal-ammoniac; all by measure.

The materials should be thoroughly mixed dry and then wet down to the consistency of common mortar, constantly stirring the mass as the wetting proceeds. A rough mold shaped to fit the tuyere opening, a trowel and a few minutes' time are all that are needed to complete the successful claying of the forge. This mixture dries hard and when glazed is very durable.

Stanley H. Moore.

CLEANING SOLUTIONS

When metal parts require cleaning, it is advisable to use commercial cleaning solutions and apparatus, especially in shops where the amount of cleaning and the effectiveness of the cleaning process are important factors. This section deals with miscellaneous cleaning solutions; some of these are for metals and there are others for various purposes.

Soda Cleaning Solution

Soda solutions are used for cleaning oil and dirt from work in machine shops. Soda ash, the chemical formula of which is Na_2CO_3, has largely superseded potash solutions for cleaning purposes, because it is cheaper and, for most work, better than potash. The value of soda ash and potash solutions for cleaning purposes is that these chemicals combine with grease and, therefore, act as cleansing agents.

The solution used in soda kettles for removing oil or grease from machine parts should contain about one-half pound of sal soda to each gallon of water. If old paint is to be removed, the solution should consist of about one-quarter pound of caustic soda to each gallon of water. As caustic soda is strong alkali, care should be taken to prevent it from getting onto the hands. These solutions should be heated to the boiling point before immersing the parts to be cleaned; then the work will dry quickly after being removed, and will not rust. A wire basket or perforated bucket is convenient for washing small pieces. The time required for cleaning depends somewhat upon the nature of the grease and to what extent it has dried and hardened.

To Clean Brass Castings

Brass work that has become dirty or corroded in service may be cleaned in the following solution: 1/3 part nitric acid, 2/3 part sulphuric acid, and 1/2 pound common salt to each 10 gallons of solution. Dip the castings in the solution for half a minute and then rinse in boiling water and dry in pine sawdust. E. W. Bowen.

Cleaning Solution for Brass

To make a cleaning solution for brass work, mix 1 1/2 ounces nitric acid, 1 dram saltpeter, 2 ounces rain water. Let the mixture stand a few hours and then the articles to be cleaned may be dipped in quickly and then rinsed off and dried. R. M. K.

To Clean Nickel-plated Parts

Use a solution of alcohol to which has been added 2 per cent of sulphuric acid. The part to be cleaned is immersed in this solution, about 5 seconds ordinarily, and 15 seconds for dull parts. After removing the work, wash in running water, rinse in alcohol, and rub dry with a linen cloth.

To Restore Tarnished Gold

Use sodium bicarbonate, 20 ounces; chlorinated lime, 1 ounce; common salt, 1 ounce; water, 16 ounces. Mix well and apply with a soft brush. One or two drops are sufficient for small articles.

To Remove Hard Grease and Paint

To remove grease, paint, etc., from machinery add half a pound of caustic soda to two gallons of water

and boil the parts to be cleaned in the fluid. It is possible to use it several times before its strength is exhausted. F. PAVLIK, JR.

Oil Stains on Concrete Floors

Oil stains on concrete floors may be removed by using a mixture of 1 pound of oxalic acid in 3 gallons of water, with enough wheat flour added to make a paste that can be applied with a brush. Allow the application to remain for two days, and then remove it with clean water and a scrubbing brush. A second application may be necessary in stubborn cases. M. E.

Washing Oily Waste

The following is an excellent method of washing oily waste. The chief objection to most of the common methods employed is that the waste, after being dried, is found to be matted and of a hard, gritty texture. The common method of washing the waste, using sal soda in solution, is a good one, as far as the cleaning qualities are concerned, but it leaves the waste hard and matted, so that it is difficult to handle. A simple remedy for this is to rinse the waste (after being cleaned in the sal-soda solution), in very hot water, to which has been added a quantity of liquid ammonia. This will render the waste soft and light when dry. T. E. O'DONNELL.

For Washing Shop Windows

Soap and water are poor materials with which to wash greasy and dirty shop windows. The labor cost is excessive; the soapy water gets into the joints of the window sashes and hastens decay; and there

is liable to be a good deal of soapy water slopped over benches, tools and machines.

The following solution is very effective: Dilute alcohol with three times its bulk of water. Stir into this whiting enough to thicken it somewhat. Apply this to the glass with a cotton cloth or waste. Leave it fifteen or twenty minutes to dry. Then rub off with a cotton cloth or a handful of waste. If sashes are to be painted, there will be no need of a long wait for the wood to dry, as the alcohol will very much hasten the evaporation of the water and leave the woodwork in fine condition for the painter.

OSCAR E. PERRIGO.

Mixture for Cleaning the Hands—1

A good mixture for cleaning grimy hands is made by pounding a cake of "Sapolio" or "Bon Ami" up quite fine, and stirring it into a cupful of pure leaf lard, heated very hot. Stir until well mixed, and when it is partly cool pour into a tin or tins of convenient size to get the fingers into. M. E. HOWE.

Mixture for Cleaning the Hands—2

To loosen the oil and grease, the hands should first be scrubbed with a stiff brush dipped in kerosene, and then they should be wiped dry with waste. Take a five-cent box of soap powder, add to it an equal quantity of white sand. Mix thoroughly and rub over the wet hands in the form of a paste. This compound will rinse off in any kind of hard or soft, hot or cold water. Hands washed in this manner twice a day will be free from grime and clean all over.

H. J. BACHMANN.

Lard for Cleaning the Hands

The next time you work on cast iron or on an old bearing all covered with soft, black muck, try ordinary lard as a cleanser for the hands. While hand soaps prepared for the purpose do good work, they are not always available, and in some cases thin-skinned people find that they remove the skin together with the grime. Lard oil does not work well and leaves its odor on the hands, while the lard is free from this objection and can be easily washed off with soap. If an abrasive is desired, add a little cornmeal to the lard. It will help dig into the dirt, and is at the same time an emollient.

As a container for the lard, the writer uses an ordinary compression grease cup, with the feed spring removed. When empty, this container can be taken home and replenished. A match cut to a chisel point and dipped in lard, if used as a supplementary operation on the finger nails, will remove the last traces of black. HERBERT A. FREEMAN.

Cleaning Fluid for Fine Fabrics

This cleaning fluid may not be of much use in the shop, but if some machinist should get the machine shop grime on his "Sunday-go-to-meeting" trousers, he will find it useful for cleaning out the spots; it works like magic: Sulphuric ether, three drams; alcohol, six drams; chloroform, three drams; gasoline, one quart. The mixture can be used safely for cleaning the most delicate fabrics, but being highly inflammable, it must be used with caution around fires and open lights. M. E. CANEK.

COATINGS FOR LAY-OUT LINES

In order that the lines drawn upon metal surfaces may be plainly visible, some suitable preparation is applied to the surface upon which the lines are to be drawn. Common chalk or a mixture of whiting and alcohol is often used on rough castings. The whiting is sometimes mixed with water, but alcohol is preferable because it will dry quicker and does not tend to rust the surface. This mixture may be applied with a brush. For many purposes, especially when the surface of the work is comparatively rough, the surface can be coated satisfactorily by simply rubbing dry chalk over it. Castings are frequently coated in this way preparatory to laying-out operations. As lines which are drawn on a chalked surface are quite easily obliterated, permanence is given them by marking their location with small center-punch marks.

Copper-sulphate Solution

When iron or steel surfaces have been machined, they can be coated by moistening the surface and rubbing it with a piece of copper sulphate or bluestone. The following copper-sulphate solution gives even better results: To 4 ounces of distilled or rain water, add all the copper sulphate that the water will dissolve; then add ten drops of sulphuric acid. Test by applying to a piece of steel and, if necessary, add four or five additional drops of acid. The thin copper film which is deposited by this solution makes it possible to easily see fine lines because of the difference in color between the copper and the metal beneath. For this reason, the copper-sulphate so-

lution is very often used, especially when fine lines are required. The surface to be coppered should be polished and free from grease. Apply the solution with clean waste, and, if a bright copper coating is not obtained, add a few more drops of the solution; then scour the surface with a fine emery cloth and apply immediately a small quantity of fresh solution.

The copper-sulphate solution can also be used on brass by simply sprinkling iron filings on the brass surface, and then applying the copper sulphate solution. The surface to be coated should in all cases be free from oil, grease, etc.

Zinc Chloride Coating Solution

A copper coating solution for use when laying out work on iron or steel which I have found more satisfactory than the ordinary blue vitriol is a mixture of a saturated solution of zinc chloride with a very little copper sulphate added, say a half-dozen drops of copper sulphate to a spoonful of zinc chloride solution. When a piece of steel is rubbed with waste moistened in this solution it produces a bright copper surface that does not easily rub off.

MILTON BURGESS.

Copper Solution for Oily Steel

To make a copper solution that will color on oily steel, take 1/2 ounce sulphate of copper (blue vitriol), 4 ounces water, 1 tablespoonful oil of vitriol (commercial sulphuric acid) and dissolve the sulphate of copper in the water; then slowly add the oil of vitriol, a few drops at a time, shaking well at each addition. Keep the mixture away from the face when adding the oil of vitriol; if the oil of vitriol is poured

in the bottle all at once the stuff will boil and shatter the bottle. F. W. B.

To Coat Iron with Copper

Polish the iron by rubbing it well with cream of tartar, and afterward with charcoal powder, and place the metal in hydrochloric acid diluted with three times its volume of water, in which a few drops of a solution of sulphate of copper is poured. After a few minutes withdraw the iron and rub with a piece of cloth, then replace it in the solution, to which add another portion of sulphate of copper. By following this plan the layer of copper may be increased at pleasure. Finally, immerse the iron in a solution of soda, wipe clean and polish with chalk. The coating thus obtained will be firm and durable. U. Peters.

White Coating—1

Mix whiting and white lead with boiled linseed oil to a thick paste; add some japan dryer, and thin with benzine or gasoline. This makes a fine preparation for whitening sheet iron and other work previous to laying out, as any lines drawn on the surface show up very distinctly. It also makes a very good stenciling or marking paint.

A. D. Knauel.

White Coating—2

For laying out work on structural iron or castings a better way than chalking the surface is to mix whiting with benzine or gasoline to the consistency of paint, and then paint it with a brush;

in a few minutes the benzine or gasoline will evaporate, leaving a white surface ready to scribe lines on.

A. D. KNAUEL.

To Copper Brass for Laying Out Work—1

To apply a copper coloring upon brass for laying out work, put a few drops of the ordinary coppering solution upon the brass and then dip a piece of iron or steel into the solution and touch the brass.

OSCAR J. BEALE.

To Copper Brass for Laying Out Work—2

To apply a copper coating on brass for laying-out purposes, apply the ordinary copper solution in the same manner as used on iron or steel. Then, while the brass is still wet with this solution, cover the entire surface with a thin layer of fine cast-iron dust from the drill press. Brush off the cast-iron dust, and the surface will have a nice copper coating.

C. S.

To Blacken Zinc for Laying Out

The following receipt is often used for coating iron or steel, but it is not generally known among many of the craft that it may be used to prepare zinc for sketching, giving the zinc a dark coating. Dissolve 1 ounce sulphate of copper in 4 ounces water, add 1/2 teaspoonful of nitric acid and apply a thin coating to the zinc with a piece of waste. If used for iron or steel, the work should then be rubbed dry. Care should be taken in handling and using the mixture, as it rusts iron and steel badly if left on.

R. M.

To Blacken Brass for Templet Work

The brass must be thoroughly cleaned, and then is heated slowly over a charcoal fire, care being taken not to allow the brass to touch the charcoal, or indeed not to allow any sparks from the charcoal to come in contact with the brass, as it will cause red spots. As soon as the brass is slightly red, dip it into nitric acid and reheat, just short of red. Rub strongly with a stiff bristle brush and clean with a greasy cloth. This gives a fairly permanent dead-black finish.

P. H. Oto.

To Blacken Tin for Laying Out

Very often in the shop and also in the drawing-room we want to lay out some piece of work for trial on a surface which will show fine, accurate marks. If sheet zinc is not at hand, use a sheet of bright tin plate rubbed over with a piece of waste dipped in a sulphate of copper solution. This is made of water and bluestone with oil of vitriol added in the proportion of 1 part vitriol to 50 parts water. Rub the tin thoroughly, keeping the waste wet with fresh solution and soon you will see spots of brass, then of copper, then a dark gray or nearly black surface. Wipe this dry and you will have an ideal surface to lay out on.

F. W. Bach.

COLORING BRASS

Copper is more susceptible to coloring processes than any of the other metals, and, hence, the alloys containing large percentages of copper are readily given various shades of the yellow, brown, red, blue, and purple colors, and also black. Alloys with smaller percentages of copper, or none at all, can be given various colors, but not as easily as if copper were the principal ingredient, and the higher the copper content, the more readily can the alloy be colored.

Yellow or Orange Colors on Brass

Polished brass pieces can be given a color from a golden yellow to an orange, by immersing them for the correct length of time in a solution composed of 5 parts of caustic soda to 50 parts of water, by weight, and 10 parts of copper carbonate. When the desired shade is reached, the work must be well washed with water and dried in sawdust. Golden yellow may be produced with the following: Dissolve 100 grains of lead acetate in 1 pint of water and add a solution of sodium hydrate until the precipitate which first forms is redissolved, and then add 300 grains of red potassium ferrocyanide. With the solution at ordinary temperatures, the work will assume a golden yellow, but heating the solution darkens the color until, at 125 degrees F., it has changed to a brown.

Gold Color on Brass

A rich gold color can be given brass by boiling it in a solution composed of 2 parts of saltpeter; 1 part of common salt; 1 part of alum; 24 parts of water,

by weight; and 1 part of hydrochloric acid. Another method is to apply to the work a mixture composed of 3 parts of alum; 6 parts of saltpeter; 3 parts of sulphate of zinc; and 3 parts of common salt. The work is then heated over a hot plate until it becomes black, and then washed with water, rubbed with vinegar, and again washed and dried.

Green Color or Antique Finish

One solution that will produce the verd antique, or rust green, is composed of 3 ounces of crystallized chloride of iron; 1 pound of ammonium chloride; 8 ounces of verdigris; 10 ounces of common salt; 4 ounces of potassium bitartrate; and 1 gallon of water. If the objects to be colored are large, this can be put on with a brush and several applications may be required to give the desired depth of color. Small work should be immersed, the length of time it is immersed governing the lightness or darkness of the color. After immersion, stippling the surface with a soft round brush, dampened with the solution, will give it the variegated appearance of the naturally aged brass or bronze.

To Produce a Gray Color on Brass

First clean off with alcohol, polish the surface to an even finish, making sure that grease or finger marks are removed. Then immerse in a solution of one ounce of arsenic chloride to one pint of water until the desired color is obtained. Wash in clean, warm water; dry in boxwood sawdust; warm; lacquer with a thin pale solution of bleached shellac in methyl alcohol, using a broad camel's hair brush.

Donald A. Hampson.

Silver Finish on Brass

A method of silvering that is applicable to such work as gage or clock dials, etc., consists of grinding together in a mortar 1 ounce of very dry chloride of silver, 2 ounces of cream of tartar, and 3 ounces of common salt. Then add enough water to make it of the desired consistency and rub it on the work with a soft cloth. This will give brass or bronze surfaces a dead-white thin silver coating, but it will tarnish and wear if not given a coat of lacquer. The ordinary silver lacquers that can be applied cold are the best. The mixture, as it leaves the mortar before adding the water, can be kept a long time if put in very dark-colored bottles; but, if left where it will be attacked by light, it will decompose.

Silver Paste for Brass

This paste is used for silvering the scales on thermometers and the dials of clocks, aneroid barometers, steam gages, etc.

Put in an ordinary tea-cup, or other suitable vessel, 1 ounce of silver—coin silver will do, but pure silver is better and cheaper. Fill the cup half full of nitric acid, and place it in a vessel containing water, which must be heated. As the acid heats, it throws off very poisonous fumes in the shape of a brown smoke. When the smoke ceases to appear, add a teaspoonful cf common table salt, and when the fumes caused by this cease, take the cup from the heat immediately and fill slowly to the top with cold water. Allow the white powder that will now be found in the cup to settle to the bottom and then slowly decant the liquid. When almost empty, fill again with cold water, and decant again, repeating this process at

least half a dozen times. Mix the powder (commercial chloride of silver will do instead) with 10 pounds table salt, and 1/2 pound cream of tartar. Mix thoroughly dry, then add enough cold water to make a paste. Add the water slowly so as not to get in too much. Keep in a covered vessel and from the light.

The piece to be silvered should be thoroughly cleaned with emery cloth or paper just before applying the paste, which is to be put on by hand and rubbed well in the surface of the work. After this is done, the work should have a dirty, silvery yellow tinge, which will be brightened by rubbing with a dry mixture of 1/2 pound cream of tartar and 10 pounds salt well mixed. The work should be thoroughly washed to clear it of the surplus salt and then dried in sawdust and lacquered. This method has been used for silvering over 30,000 steam gage and clock dials, and many other dials and scales.

J. S. Gordon.

White Coatings

The white color or coating that is given to such brass articles as pins, hooks and eyes, buttons, etc., can be produced by dipping them in a solution made up as follows: Dissolve 2 ounces of fine grain silver in nitric acid, then add 1 gallon of distilled water and put into a strong solution of sodium chloride. The silver will precipitate in the form of chloride, and this must be washed until all traces of acid are removed. Testing the last rinse water with litmus paper will show when the acid has disappeared. Then mix this chloride of silver with an equal amount of potassium bitartrate (cream of tartar) and add

enough water to give it the consistency of cream. The work is then immersed in this mixture and stirred around until properly coated, after which it is rinsed in hot water and dried in sawdust.

Silver-white Bronze

To prepare silver-white bronzing powder, melt together one ounce each of bismuth and tin, adding one ounce of mercury. When cool, pulverize into a fine powder. R. P. PERRY.

Frosting Brass Work

Boil the brass in caustic potash, rinse in clean water, and dip in nitric acid till all oxide is removed; then wash quickly, dry in warm boxwood sawdust, and lacquer while warm. This will give brass an ornamental finish. F. H. JACKSON.

To Blacken Brass—1

For blacking brass use chloride of antimony. The articles should be thoroughly cleaned and polished, then immersed in the solution for a short time, and dried over a spirit lamp; then brush with a black lead brush. F. H. JACKSON.

To Blacken Brass—2

Dip the article, cleaned bright, in aqua fortis (nitric acid); rinse the acid off with clean water, and place it in the following mixture until it turns black: Hydrochloric acid, 12 pounds; sulphate of iron, 1 pound; and pure white arsenic, 1 pound. It is then taken out, rinsed in clean water, dried in sawdust, polished with black lead and lacquered with green lacquer.

JOS. M. STABEL.

To Blacken Brass—3

To give a dull black surface to brasswork, paint it with a mixture made of a thimbleful of lampblack, to which is added 4 or 5 spots of gold size. Mix well with a knife on a flat slate until the whole is about as thick as putty. Only put sufficient gold size to make the lampblack stick together, as too much will make a bright instead of a dull black. Add about twice the volume of turpentine to the mixture, stir well with a camel's hair brush, and apply to the brasswork. JOS. M. STABEL.

To Blacken Brass—4

Should it be desired to change the color of an article made of brass to a dark bronze or black, the following compound will be found to give good results, especially if the metal has a polished surface. First make up a solution of 120 grains of nitrate of silver and 5 ounces of water; then dissolve 120 grains of copper nitrate in 5 ounces of water. Mix the two solutions together in equal parts, making a quantity sufficient to immerse the articles. Clean thoroughly in hot soda water the brass articles to be blackened, and then dip in the above compound. Remove and heat in an oven until the proper shade of color appears. T. E. O'DONNELL.

To Blacken Brass—5

An old solution known to the plating industry for many years is made as follows: Water, 1 gallon; sugar of lead, 8 ounces; hyposulphite of soda, 8 ounces.

The solution is used as hot as possible, and the brass work is simply dipped in it and allowed to

remain until black. This takes about a minute or less. The articles are then rinsed in cold water, then in hot water and dried. If scratch-brushed dry, the black deposit will have a high luster.

When dipped into the solution, the surface of the brass article becomes yellow, then blue and finally black. The article should not be taken out until all the surface has become blackened. The deposit on it is sulphide of lead. The articles should always be lacquered, as the black deposit is likely to oxidize and fade if not; but if coated with lacquer, it seems to be quite permanent.

For a cheap class of goods that require a black finish, this solution can frequently be used to good advantage. It requires no electric current, being used as a dip. The color is not coal black, but resembles a graphite black more than anything else and has a slight gray shade. It is sufficiently black, however, to answer many purposes and it is so easily applied that it can be used on cheap goods with only a slight increase in cost.

To Blacken Brass—6

A satisfactory method of oxidizing brass is as follows: Prepare a solution of copper nitrate by dissolving pure copper in commercially pure nitric acid until all action ceases. This should be done in a large jar out of doors, as the chemical action throws off a dense brown vapor which will rust steel or iron, and the volume of the acid increases as it heats. After all action ceases and the mixture becomes cold, the clear liquid is decanted into another jar. Sandblast the work or clean it thoroughly by some other method, so that it is free from grease of any kind.

Work washed in a solution of hot lye and soda, dried in sawdust, and then kept from contact with the fingers or grease until the blackening solution is applied, will give the best finish.

Heat the work to a temperature of about 212 degrees F., or the boiling point of water; immerse it in the copper-nitrate solution, then remove and heat again until it is just hot enough to dry off the solution and to burn off the green color which appears. This process may be repeated, if it is thought necessary. The work is then cooled and all free oxide removed by brushing, after which it is dipped in ammonia and rubbed dry with a soft cloth or in sawdust. This will leave the work with a brownish color. To get the dead-black color, heat the piece to a temperature that is not high enough to burn the hands, but very warm, and rub it with a piece of soft leather having a few drops of pure olive oil on it, after which it should be heated enough to dry the oil.

Highly polished work, if well cleaned and dipped in commercial ammonia before applying the copper nitrate, will take a permanent black. Work that is sand-blasted takes a black that cannot be removed by ordinary wear.

Durable Heat-black Finish

The so-called "heat-black" finish on brass, copper, or bronze is one of the most durable. It is adapted for a large variety of work and is replacing nickel-plated work for certain articles. Some desk telephone sets, for example, are now being finished in "heat-black." The color is an absolute dead black, and, as it is not difficult to apply, it will, no doubt,

be extensively employed. It can be applied to brass, bronze, or copper, but it does not work evenly on steel or iron. The article to be treated should be free from grease, although a slight tarnish will not affect it. A sand-blasted surface takes an excellent finish, although very good results may be produced without it, as the only difference between the results obtained is that the sand-blasted surface is a little more "dead."

Solutions for Heat-black Finish

Two stock solutions are first made up. One is a solution of nitrate of copper in water, and the other is a solution of nitrate of silver in water. The proportions need not be exact, although it is preferable to keep them fairly close to the figures given.

1. The *nitrate of copper solution* is composed of water, 1 ounce; and nitrate of copper, 1 ounce. This gives a practically saturated solution of nitrate of copper in water and is used for a "stock" solution. If desired, the nitrate of copper may be easily made by taking 1 ounce of strong nitric acid and dissolving in it all the copper wire it will take up. A thick, blue solution is left which is used for the stock solution. As few platers have nitrate of copper in stock, it can easily be made from copper wire.

2. The *nitrate of silver solution* contains water, 1 ounce; and nitrate of silver, 1 ounce. This solution can also be made by dissolving pure silver in nitric acid until no more will dissolve, but dilute acid (1 part acid and 1 part water) should be used, as silver does not dissolve readily in strong nitric acid. It is preferable, however, to purchase the nitrate of silver, as it is easily obtained. The nitrate of silver

solution is practically a saturated solution and is used as the stock solution.

3. The mixed solution for applying to the metal is made as follows: Water, 3 parts; nitrate of copper solution, 2 parts; nitrate of silver solution, 1 part. The solution is kept in a glass or stoneware vessel for use.

Applying Heat-black-finish Solution

The application of the solution by means of a brush or a cotton swab is not recommended, the fumes generated by the acid on the hot brass being very noxious and injurious. A more satisfactory application of the solution is as follows: The parts to be treated, freed from grease, are heated over a bright charcoal fire, or by means of a gas torch, under a hood, by the side of the tank containing the solution. The solution is kept in a china or stone basin of suitable proportions for the work to be treated; such basin is covered with a wooden cover, and kept under the hood connected with the chimney drawing out the fumes generated when the parts are dipped in the solution.

After the parts have been dipped, they are allowed to drain over the basin for a few seconds, and then heated again until the green froth is burnt and black. If the charcoal fire is used, care must be taken that the wet parts do not touch the coals, as this would cause discolored spots at every point of contact. It will not be detrimental to have the parts lying on the fire when they are dry and green all over. The brushing is made over a tank full of water by means of a wet brush, to prevent inhaling the irritating dust. The parts are allowed to dry and afterwards

may be finished, as already explained, or they may be smeared with oil, dried in sawdust, and brushed again, or else polished with black lead.

One or two coatings of the solution on the surface of the article is usually enough; it dries almost immediately, leaving a green froth. The temperature is not sufficiently high to draw the temper of hard brass, but it will usually melt soft solder. When the entire surface has changed to a uniform black color, allow the article to cool and then brush off the fluffy material on the surface of the metal with a stiff-bristled brush. The color will now change to a brownish black that is quite pleasing for many purposes and very tenacious. When the fluffy material is completely brushed off, it leaves an even and uniform coating. If the brown-black finish is desired, the surface may now be waxed or lacquered, but it is usually customary to give the article an additional treatment in a liver of sulphur solution in order to change the brown-black coating to one that is absolutely dead black.

Final Treatment for Heat-black Finish

When the smut has been brushed off from the surface of the article, it is immersed in a cold liver of sulphur solution for 5 minutes. This solution is made by dissolving 2 ounces of liver of sulphur in 1 gallon of water. The article is immersed in it, allowed to remain about 5 minutes and then, without rinsing, is again heated until the surface is uniformly black. The surface is now brushed again with the bristle brush, when it will be found that the color is a dead black and quite uniform. It should be remembered that the article is not rinsed

at all after it is removed from the liver of sulphur solution, but is simply drained off and then heated.

If the article is lacquered with a flat lacquer or waxed, as may be desired, the final appearance of the surface will be found quite satisfactory. The coating of the solution that is first applied need not be very even as long as a sufficient quantity is put on.

If the surface is not satisfactory, or an old article is to be refinished, the wax or lacquer may be burned off and the process repeated. This is practically one of the most satisfactory black finishes known, as it is dead black, is readily applied, and very durable. It is calculated to resist considerable handling, such as a desk telephone would receive. There are many articles that can well be treated by it.

For Bluing Small Brass Articles

To blue small brass articles by immersion, use chloride of antimony, 1 ounce; water, 20 ounces; hydrochloric acid, 3 ounces. Place the solution in an earthen jar and suspend the piece in this bath until blue; then wash and dry in sawdust. The pieces should be warmed first.

To blue steel without heat, apply nitric acid; wipe off the acid clean, oil and burnish. L. E. Muncy.

To Color Brass Blue-black—1

A permanent and beautiful blue-black can be obtained by using just enough water to dissolve 2 ounces of copper sulphate and then adding enough ammonia to neutralize and make it slightly alkaline. The work must be heated before immersion. Copper nitrate, water, and ammonia will also yield this rich blue-black, but if the brass is very highly heated

after immersion it changes to a dull steel black. On copper or work that is copper-plated, this latter produces a crimson color.

To Color Brass Blue-black—2

To color brass blue-black, make a solution of ammonia and copper carbonate in the approximate proportion of 10 parts of ammonia and one part of copper carbonate, by weight. Shake the mixture well until the copper carbonate is dissolved, adding the copper carbonate to the ammonia, little by little, until the ammonia will not dissolve any more; then add a volume of clear water equal to about one-fourth of the mixture. The brass to be colored should be polished bright, either with fine dry emery cloth, taking care not to touch the polished surface with the fingers, or made clean and bright by dipping in a strong solution of caustic soda. Before dipping, agitate the compound thoroughly and then immerse the pieces of brass, keeping them in motion two or three minutes; rinse off in clean water, and dry in sawdust or clean cotton waste. When not in use the solution should be kept in a tightly corked bottle. This has been used on instrument work very successfully. H. M. WEBER.

Lilac Colors on Brass

The lilac shades can be produced on yellow brass by immersing the work in the following solution when heated to between 160 and 180 degrees F. Thoroughly mix 1 ounce of chloride, or butter, of antimony in 2 quarts of muriatic acid, and then add 1 gallon of water.

Violet Colors on Brass

A beautiful violet color can be produced on polished brass with a mixture of two solutions. First, 4 ounces of sodium hyposulphite is dissolved in 1 quart of water, then 1 ounce of sugar of lead is dissolved in another quart of water, and the two are well stirred together. By heating this mixture to 175 degrees F. and immersing the work the correct length of time, it takes on the violet color. The work first turns a golden yellow and then gradually turns to violet. If left a longer time the violet will turn to blue and then to green. Thus, this same preparation can be used for all of these colors by correctly limiting the time that the work is immersed.

Variations in Color

Very good results in coloring brass can be obtained by dissolving 200 grains of sodium thiosulphate and 200 grains of lead acetate in 1 pint of water, and heating to from 190 to 195 degrees F. Immersing the work in this for 5 seconds will make it pale gold; 15 seconds, brown gold; 25 seconds, crimson; 20 seconds, purple; 45 seconds, an iridescent bluish crimson green; 60 seconds, pale blue; 65 seconds, mottled purple; 80 seconds, nickel color; 85 seconds, mottled blue and pink; 110 seconds, mottled purple and yellow; 2 1/2 minutes, pale purple; 4 minutes, mottled pink and yellow; 5 minutes, mottled gray; 10 minutes, mottled pink and light blue. Other combinations of colors can also be obtained, but some of these fade and change color unless protected by a coat of lacquer. By using one-quarter ounce of sulphuric acid in place of the

lead acetate, a variety of colors can also be produced, but they will not be as good a quality as those made with the above solution. Nitrate of iron can also be used.

To Bronze Yellow Brass

To produce a bronze finish on rough yellow brass castings, mix equal parts of nitric acid, sulphuric acid and water; the nitric acid and water should be mixed first and the sulphuric acid added slowly Dip the yellow brass castings into boiling water a moment, then in the acid solution, then quickly back into the boiling water, and rinse thoroughly in clean water. Dry in pine sawdust. The castings must be perfectly free from soldering solutions, etc., or stains are liable to appear. This method gives a finish similar to gas fixtures, etc., and may be rendered very permanent by coating with a transparent lacquer. I. W. Antano.

Mat Dip for Brass

To make a mat dip for brass, mix 1 part sulphuric acid in 1 to 2 parts of nitric acid and 1 part sulphate of zinc. Let the mixture stand 24 hours, and use hot. More or less nitric acid gives a fine or coarse effect, as may be preferred.

J. L. Lucas.

Bright Dip for Brass and Copper

A bright dip for brass, copper and bronze may be produced as follows: Make a solution of 100 parts, by weight, of nitric acid, 50 parts sulphuric acid, 1 part soot, and 1 part salt. The salt and soot make

the dip work smoothly. The article should be dipped in this solution, well washed, and dried in sawdust to prevent streaking. S. H. SWEET.

Recoloring Bronze

Bronze may be renovated and recolored by mixing one part muriatic acid and two parts water, and applying the diluted acid to the bronze articles with a cloth. Before applying the acid the articles should be cleaned thoroughly from all grease. After having applied the acid, let the article dry, and then polish with sweet oil. E. W. NORTON.

Varnishing and Lacquering

Varnishing and lacquering cannot be used to produce an artistic color effect, but are generally used for protecting the surfaces of instruments and machines from discoloration by atmospheric influence. In nearly every instance lacquering is used only on metal alloys. The discoloring action upon metals takes place to the greatest extent upon tin and the least upon gold. In the following list of metals the action becomes less from the first to the last: 1, Tin; 2, nickel; 3, aluminum; 4, manganese; 5, iron; 6, copper; 7, zinc; 8, lead; 9, platinum; 10, silver; 11, gold.

Lacquer for Brass

The following process makes a very good lacquer for the brass parts of fine instruments. Make four alcoholic solutions in separate bottles of each of the following gums: Unbleached shellac, dragon's blood. annato, and gamboge, in the proportions of about

one ounce of the gum to a pint of alcohol. Keep these solutions about a week in a warm place, on a hot water or steam radiator, for instance, shaking the bottles frequently. It will be found that the alcohol will not dissolve all of the gum, but that within half an hour after shaking, a precipitate will settle on the bottom of the bottle, leaving a perfectly transparent but highly colored liquid above, which deepens in color from day to day. Decant this and filter through cloth, placing the liquids in tightly corked bottles.

A word of caution should be given in the case of shellac. The yellow opaque shellac varnish of the pattern-maker is useless; but, if the above proportions are used, and the solution kept warm, say 130 to 180 degrees F., a light flocculent precipitate will settle out, leaving a transparent wine-colored liquid above. It is this liquid which must be used. The four solutions should now be mixed. Equal parts of each give a rich golden yellow. After mixing, the solutions should be boiled down to about one-third of the volume, great care being used not to ignite the alcohol. Heat a piece of cast iron over a Bunsen burner, and as soon as this is hot, turn out the burner and place the solution on the iron and allow it to boil. When it ceases to boil, repeat the process. When cold, this solution may be applied with a brush to the brass in the usual way, the brass having been polished with jewelers' fine emery paper, and slightly warmed. Though slightly harder to apply than the commercial lacquers, this solution possesses none of the disagreeable odor of the banana oil which is commonly found in lacquers, and partly for this reason it is recommended. H. C. Lord.

Cleaning Work to be Colored

Cleaning the work is of the utmost importance before attempting to give it any kind of color. A good method of removing the surface films, without heating, is to soak the work in a "pickle" composed of spent aqua fortis until a black scale is formed, and then dip it for a few minutes into a solution composed of 64 parts of water; 64 parts of commercial sulphuric acid; 32 parts of aqua fortis; and 1 part of hydrochloric acid. After that the work should be thoroughly rinsed several times with distilled water. If the strong aqua fortis is used for the pickle in which the work is soaked, it will cause a too rapid corrosion of the copper during the time of the solution of the protoxide. Hence, the spent aqua fortis is more satisfactory, on account of its slower action, and it also saves the cost of new aqua fortis.

COLORING STEEL

A method of bluing steel, in order to obtain pleasing color effects, known as the niter process, consists in melting niter or nitrate of potash, also called "saltpeter," in an iron pot at a temperature of about 600 degrees F. The parts to be blued are cleaned and polished and immersed in the molten nitrate of potash until a uniform color of the desired shade has been obtained. This requires only a few seconds. The articles are then removed, allowed to cool, and the adhering niter washed off in water. If there is no danger of warping, the parts may be immersed in the water immediately after having been removed from the nitrate-of-potash bath. The articles are then dried in sawdust, and linseed oil is applied to prevent rusting. To secure uniform colors, a pyrometer should be used to gage the temperature of the nitrate-of-potash bath, because high heats will produce darker colors, whereas lower heats will give lighter shades.

Bluing by Heating

Mix one part clean sand with one part powdered charcoal; heat the whole evenly in a pan or convenient receptacle until the piece which has first received its finishing polish and been covered by the mixture comes to the desired color. When cool, wipe dry with a cloth. NERALCM.

To Blue Steel without Heating

To blue steel without heating it, connect a small steam pipe to a wooden box so that steam may flow

continuously into it. Put a bath of the following ingredients in the box: Iron chloride (muriatic tincture of steel), 1 ounce; alcohol (spirits of wine), 1 ounce; corrosive sublimate (mercury bichloride), 1/4 ounce; aqua fortis (strong nitric acid), 1/4 ounce; bluestone (copper sulphate), 1/8 ounce; and water, 1 quart. The vapor arising from this mixture forms a deposit on the articles. After having been exposed to the vapors for a number of hours, they are rubbed off with a cloth, and the operation repeated if a darker hue is required. W. J. KAUP.

Bluing Solutions

To blue gun barrels and other pieces, dissolve 2 parts of crystallized chloride of iron; 2 parts solid chloride of antimony; 1 part gallic acid in 4 or 5 parts of water; apply with a small sponge, and let dry in the air. Repeat this two or three times, then wash with water. and dry. Rub with boiled linseed oil to deepen the shade. Repeat this until satisfied with the result. F. L. ENGEL.

Steel-blue Enamel

A steel-blue enamel, suitable for applying to steel and also other metals to give them a steel-blue polished surface, may be made in the following way: Dissolve 1 part of borax in 4 parts of water. Macerate 5 parts bleached shellac in 5 parts of alcohol. In a small quantity of alcohol dissolve some methylene blue of sufficient amount to give the color desired. Heat the first or watery solution to boiling, and while constantly stirring add the alcoholic solution. Stir until all the lumps are dissolved, and then add the blue solution. Before applying, the surface

to be blued should be cleaned and brightened with emery cloth. The enamel is best applied with a soft brush. The solution may be put into a bottle and set aside for future use, provided the bottle is securely corked. T. E. O'DONNELL.

How to Blue Steel Screws

Smear over the screws a little common soap, which prevents them from scaling. Then heat them to a dull red, and quench in water. If a screw-head tool is available, such as watchmakers use, put the screws into that, and with a piece of stone first, and afterward with crocus emery cloth, polish the head. Finish off with rouge on a buffing wheel and see that there is no grease left on the heads. Now take a piece of thin brass, drill some holes in it, and in these drop the screws—say, half a dozen—and heat them over a lamp. Watch the color as it turns from yellow to purple and then to blue. The finest blue is just before it turns to a slate color. They must be heated very gradually or you will not be able to stop the color in time. H. D. CHAPMAN.

Gun-metal Finish on Steel

The surface should first be cleaned from grease and dirt by boiling in a potash solution containing one pound of potash to one gallon of water. The scale and oxide are then removed by a pickling solution consisting of one part of sulphuric acid to twenty parts of water. After pickling, the work is thoroughly washed and scratch-brushed and then a chemical solution is used to obtain the gun-metal finish. Various compositions are used for this pur-

pose. One consists of one part of ferric chloride, eight parts of alcohol, and eight parts of water.

Brown Finish on Steel

To produce the rich brown finish that is commonly used on large guns, use sulphate of copper, 1 ounce; sweet spirits niter, 1 ounce; distilled water, 1 pint.

Four coats are applied; allow several hours to elapse between the successive coats, brushing after each, if necessary. After the last coat, rub down hard and allow to dry 24 hours. This gives a reddish brown color without gloss. By adding arsenic to the mixture before the last coat a deeper hue is obtained. The polish is obtained by means of a mixture of boiled oil, beeswax, and turpentine, comparatively thick. Rub in well with cotton cloth and finally with the palm of the hand.

R. P. Perry.

To Brown Rifle and Pistol Parts

The following formula for browning rifle and pistol parts has been found to give very good results. Coat the metal to be browned with a solution of copper sulphate, either by dipping or with a camel's hair brush. When the metal is well coated or plated with copper, wipe it dry with clean cotton waste or a cloth. Then apply ammonium sulphide solution by dipping or with a brush, being careful to cover all parts touched by the copper-sulphate solution. After the ammonium sulphide has acted for about thirty seconds, dry the work by normal pressure on the surface with clean waste or a cloth. No heat is required for the above process.

The copper-sulphate solution is made up as follows: 25 per cent copper sulphate ($CuSo_4$); 74 per cent water (H_2O); 1 per cent muriatic acid (HCl). The ammonium-sulphide solution is made by dissolving chemically pure $(NH_4)_2S$ in water.

The color produced will be similar to the browning done at the Springfield Armory, and is due to the copper sulphide, produced on the outside surface of the copper plate previously deposited by the chemical action between the copper and ammonium sulphide. The copper sulphide is a stable compound and affords good protection to the metal browned in this way. The copper plating beneath the sulphide also provides a safeguard against rust. The same result could be used for browning other classes of work. CHARLES F. SCRIBNER.

Black Finish on Steel—1

A good black finish can be produced on steel by the following method: Prepare a saturated solution of caustic soda and add a small amount of saltpeter, say a small handful to a five-gallon solution. Boil the solution for a short time and allow it to cool overnight. The clear liquid only should be used, and this should be brought to the boiling point in an iron kettle. The articles should be wired as for plating and immersed in the blackening solution. The articles will take on a gray color at once with black underneath and should be left in the solution until the gray finish disappears and a beautiful black remains. Rinse the articles in cold water, dry in sawdust and oil with linseed oil, and wipe clean. The resulting finish will be a fine blue-black that wears well, and is suitable for shears, razors, etc.

Black Finish on Steel—2

Mutton suet burnt on a polished surface produces a brilliant black which is very lasting. H. T. MILLAR.

Black Marks on Graduated Surfaces

The scale is varnished over with a little thin shellac varnish, so as to sink into all the cuts. When this is dry, a black varnish of lampblack and shellac is spread on, so as to fill all the cuts. This is allowed to dry thoroughly. When hard, the work, if circular, is placed in the lathe, and the superfluous varnish polished off with fine flour emery cloth until only that in the cuts is left. This gives a very distinct marking and fine finish to the scale.

F. H. JACKSON.

Bronzing Fluid for Steel

To obtain a light bronzing fluid, use nitric acid, 6 parts; nitric ether, 5 parts; alcohol, 5 parts; muriate of iron, 5 parts. Mix thoroughly and then add 10 parts sulphate of copper dissolved in 50 parts of water. O. G.

Enamel for Iron or Steel

Make an enamel by mixing 2 ounces of burnt umber with 1 quart boiled linseed oil, heating and then adding 1 ounce asphaltum. Keep hot until thoroughly mixed, and thin with a small quantity of turpentine. Have the surface of the parts to be enameled thoroughly cleaned, and apply the enamel with a camel's hair brush, and allow it to set. Then place in an oven and bake for 6 hours, at a temperature of 250 degrees F. When cool, rub down with steel

wool, and then apply the finishing coat of the desired color, and allow to bake for 6 or 8 hours. Rub down, when cool, with a soft cloth, then varnish and bake again at 200 degrees F. The heating and cooling should be done gradually each time so as not to crack the enamel. Black enamel usually requires a higher degree of temperature than any other kind, or about 300 degrees. T. E. O'DONNELL.

To Imitate Casehardening

Occasionally it becomes necessary to darken polished or ground parts to imitate casehardening; in order to accomplish this result use this mixture: 1 part nitric acid and 20 parts water. Immerse the article to be treated about 20 seconds, then rinse with clear water. A splendid result can be accomplished by following the above instructions. HARRY ASH.

To Produce a Mat Surface on Steel

To make a non-reflecting or mat surface on small steel articles, such as screws, small steel stampings, etc., which at the same time shall be perfectly rust-proof, proceed as follows: Mix 2 ounces of powdered tartar with 20 ounces of water. Put the articles to be treated into this mixture in an earthen pot, and boil until they become yellow. Then place the articles in a tray with a solution of sulphate of copper (blue vitriol); take out when copperized and put in a tray with sulphur-ammoniac. When black, take out and rinse off with water.

After the rinsing has been done carefully, mix a quantity of clean, very dry, beechwood sawdust with sufficient sweet oil to render it slightly oily. Then

thoroughly mix and rub in some powdered graphite, but only enough graphite should be added to give the whole a blackish appearance. Throw into the sawdust the steel parts to be blackened, but not more at a time than about one-third of the quantity of the mixture. Put the whole in a small coffee roaster such as is used in private houses, and after shaking well, roast the contents over a gentle flame, in constant motion, until the sawdust is burned to charcoal. The parts are then ready to be taken out and cooled. The roaster should be tightly closed during the roasting operation.

It is not necessary to lacquer the parts, as the color put on in this manner will not wear off by ordinary handling. The parts will have a nice mat surface suitable for articles used in photographic manufacture and art goods. The formula used was a secret for many years and was successfully used by the inventor.

MAX J. OCHES.

COOLANTS AND LUBRICANTS

Cutting compounds and lubricants are used in connection with most machining operations on wrought iron and steel, in order to cool the turning tool and reduce the abrasion or wear of the cutting edge, thus permitting higher cutting speeds. There are many coolants in use at the present time, some being compounds which are "homemade" and others solutions which have been placed on the market.

Compound for General Use

Many lubricants which are cheaper than oil are extensively used on "automatics" for general machining operations. These often consist of a mixture of sal soda (carbonate of soda) and water, to which is added some ingredient, such as lard oil or soft soap, to thicken or give body to the lubricant. A cheap lubricant for turning, milling, etc., and one that has been extensively used, is made in the following proportions: 1 pound of sal soda; 1 quart of lard oil; 1 quart of soft soap; and enough water to make 10 or 12 gallons. This mixture is boiled for one-half hour, preferably by passing a steam coil through it. If the solution should have an objectionable odor, this can be eliminated by adding 2 pounds of unslaked lime. The soap and soda in this solution improve the lubricating quality and also prevent the surfaces from rusting. For turning and threading operations, deep-hole drilling, etc., a mixture of equal parts of lard oil and paraffin oil will be found very satisfactory, the paraffin being added to lessen the expense.

To Turn Hard Iron and Steel

Use a drip can for the tool with the following solution: Petroleum, 2 gallons; turpentine, 1 gallon, and 2 ounces of camphor. J. H. HOLDSWORTH.

Cutting Oil for Screw Machine

Two gallons of No. 520 paraffin oil; 1 gallon of lard oil. Mix the ingredients well. This oil is used instead of a cutting compound or lard oil.

J. H. CHEETHAM.

Lubricant for Thread Cutting—1

A mixture of equal parts of lard oil and paraffin oil gives good results for threading. (The lard oil is adulterated with paraffin to reduce the cost of the lubricant.)

Lubricant for Thread Cutting—2

After trying various kinds of lubricants in cutting threads on tool steel, machine steel, etc., the writer found that common lard (not lard oil) mixed with about one-third turpentine gave the best results. The mixture may be applied with a small brush.

STEPHEN COURTER.

Lubricant for Thread Cutting—3

To make a good lubricating mixture for cutting thread in hard tool steel, use equal parts of turpentine and benzine or kerosene. For cutting in soft tool steel, mix equal parts of kerosene and lard oil. These mixtures always flow even and keep just about enough moisture at the cutting point.

EVERETT KNEEN.

For Thread Cutting and Tapping

Mineral oils should never be used in thread cutting and tapping, as they do not generally flow freely enough. An excellent solution for this purpose can be prepared by dissolving 1 1/2 pounds of sal soda in 3 gallons of warm water, then adding 1 gallon of pure lard oil. This is known as a soda solution. Pure lard oil is the best for fine, true work.

T. E. O'DONNELL.

Lubricants for Tapping

The breakage of taps can be reduced greatly by using the proper lubricant. A good grade of animal lard oil, sperm oil, and graphite and tallow mixtures (10 per cent of graphite, 90 per cent of tallow) are the best lubricants to use when tapping steel or iron. A good soap compound is better than "mineral lard oil." Machine oil is a poor tapping lubricant.

Tests made to determine the power required for tapping demonstrated that the power required when using sperm oil is 16.5, as compared with 34.2 when machine oil is used. Incidentally, this increase is almost as great as that due to decreasing the tap drill for a 1/2-inch tap from 0.425 to 0.400 inch when using sperm oil, the increase being from 16.5 to 35.5. This shows that a poor lubricant may increase the power for tapping as much as would a considerable reduction in the diameter of the hole to be tapped.

For tapping cast iron, soap compounds give excellent results, and lard oil is also used. Oil for cast iron, however, has the disadvantage of causing the chips to stick in the tap flutes, thus preventing the lubricant from reaching the cutting edges; hence, a thin lubricant is preferable. A few drops of kero-

sene will facilitate the tapping of long holes in cast iron. Only a small amount of kerosene should be used.

Compounds for Grinding

Commercial lubricants or compounds are widely used for grinding as well as for other machining operations. Water containing enough sal soda to prevent rusting may be used for grinding operations. A little oil is sometimes added to the soda water to prevent an unsightly deposit of soda on the machine or work. For form grinding, in which a broad wheel is fed straight in against the work, the following lubricant is recommended by a prominent manufacturer: Mix lard oil and soft soap in equal proportions, preferably by boiling; then add one quart of this mixture to 15 parts of water, boiling the final mixture, if convenient.

The principal reason for applying a lubricant when grinding is to localize the heat and prevent it from radiating from the point where the grinding is done, so that the work will have a more even temperature. In order to accomplish this, the lubricant should be applied at the point where the grinding action takes place. The use of a lubricant enables the grinding to be done more rapidly and tends to prevent inaccurate work.

Lubricants for Milling

A lubricant that has been extensively used for milling is made from sal soda (carbonate of soda), lard oil, soft soap, and water, as described previously under "Compound for General Use." Lard oil and animal or fish oils are also used as a lubricant, and

some manufacturers mix mineral oil with lard or fish oil. The soda solution or some of the commercial lubricants on the market are much cheaper than oil and more generally used. A mixture of equal parts of lard oil and paraffin oil is sometimes used for milling, the paraffin being added to reduce the cost of the lubricant. For fluting operations, paraffin oil, not mixed, has proved satisfactory.

Drilling Lubricants

An inexpensive compound for drilling steel can be made by adding to 30 gallons of water, 5 gallons of lard oil and 20 pounds of washing soda. Put the material in a lard oil barrel, insert a steam hose into the bung, and boil thoroughly. Do not use mineral oil or a barrel that has contained it.

When drilling hard and tough steel, use turpentine, kerosene, or soda water; for soft steel and wrought iron, lard oil, soda water, or some commercial lubricant; for malleable iron, soda water; for brass, a flood of paraffin oil, if any lubricant is used; for aluminum and soft alloys, kerosene or soda water. When drilling glass, use a mixture of turpentine and camphor. For deep-hole drilling in steel, use a mixture of equal parts of lard oil and paraffin oil. When drilling rawhide, apply ordinary laundry soap to the drill at frequent intervals.

Solution for Drilling Hard Steel—1

A mixture which will permit hard steel or iron to be drilled with ordinary drills is made by using 1 part spirits of camphor and 4 parts turpentine. Mix well and apply cold. Run the drill slowly with fine feed.

C. E. MINK.

Solution for Drilling Hard Steel—2

To drill hardened steel, make an old-fashioned flat drill and temper as hard as it will stand. Use camphor and turpentine in place of oil. G. E. HETZLER.

Lubricant for Turning Copper—1

Ordinary beeswax is a good lubricant to use when cutting threads in copper. The beeswax is rubbed onto the thread and produces a smooth finish. Milk is generally considered the best lubricant for machining copper. A mixture of lard oil and turpentine is also used for copper.

Lubricant for Turning Copper—2

A solution of sal soda mixed with lard oil is a lubricant which has been used on copper in turret-lathe work with good results. S. H. SWEET.

Lubricant for Turning Copper—3

Gasoline is an excellent lubricant. In our shop we have used it as a lubricant for cutting copper with very good results. GEORGE C. NASH.

Lubricant for Drilling Copper

The best thing, in my opinion, to use for drilling copper, especially with small drills, is a piece of tallow. This simple lubricant answers the purpose very well. GEO. W. SMITH.

Lubricants for Machining Aluminum

For aluminum, the following lubricants may be used: Kerosene, a mixture of kerosene and gasoline; soap water; or "aqualene," 1 part, water, 20 parts.

The last mixture specified has been successfully used by a large concern which machines a great many aluminum parts. This lubricant not only gives a smooth finish, but preserves a keen cutting edge and enables tools to be used much longer without grinding.

Lubricant for Turning Aluminum—1

A good lubricant for cutting aluminum in the lathe is kerosene oil. It will permit a better finish, and will materially reduce the liability of tearing the surface by the cutting tool. SREGOR.

Lubricant for Turning Aluminum—2

The following mixture makes a good lubricant for turning, or any other machining operation on aluminum: Mix 1 part good lard oil with 4 parts of kerosene oil. A. A. STEVENSON.

Lubricant for Turning Aluminum—3

To produce a smooth surface when turning aluminum, use kerosene oil for a lubricant. If turning in a turret lathe provided with an oil pump, mix the kerosene oil with lard oil: 1 part of lard oil to 3 parts of kerosene, as kerosene itself is too thin to be fed through the ordinary oil pump without being mixed with a more heavy flowing fluid. Kerosene oil is also the best lubricant for use in boring, threading and reaming aluminum. JOHN C. MONRAD.

Lubricant for Aluminum Threads

When screwing an aluminum article onto an iron or steel part, much trouble is often experienced by

the breaking and tearing of the threads of the softer metal. This can be prevented by lubricating the screw well with a mixture of oil and graphite.

SREGOR.

Lubricants for Broaching Operations

For broaching steel, cutting compounds similar to those used for other machining operations, such as turning and milling, are commonly used. A prominent broaching machine manufacturer recommends a lubricant for broaching steel containing 2 1/2 pounds of soda ash and 3 gallons of mineral lard oil to 50 gallons of water. The soda ash and lard oil are mixed with 10 gallons of water, and then the remaining 40 gallons of water added. When holes to be broached are of exceptional length, a good grade of oil is better than soda water or similar cutting lubricants, as the oil will cling to the cutting edges of the broach for a longer time. In broaching cast iron and brass, it is generally found unnecessary to use a lubricant, and in some shops aluminum is also broached dry, although it is better practice to use kerosene. A mixture of one part aqualene and twenty parts water is also recommended.

Lubricant for Drawing Dies

The following mixture has given very good results as a lubricant on drawing dies when drawing sheet metal: Boil together until thoroughly mixed, 1 pound of white lead, 1 quart of fish oil, 1 pint of water, and 3 ounces of black lead. Apply to the sheet metal with a brush before it enters the dies.

JOS. M. STABEL.

Lubricants for Drawing Brass

Several manufacturers of sheet-metal products, were asked to recommend a lubricant for drawing brass and copper, and summaries of their replies follow, each paragraph containing the information secured from a different company.

1. For drawing operations on brass, copper, etc., we have used soap for many years. Ivory soap chips mixed with water and kept warm have proved very successful. The quantity of soap used depends largely upon the thickness of the metal and the severity of the operation.

2. The lubricant used for drawing brass shells, such as cartridge shells, consists of a solution of soap dissolved in water, the consistency being changed to suit requirements. For heavy shells the solution should be thick—almost like gelatin—and for smaller shells, very thin, so that it will run through the feed-pipes without clogging. In the first cupping operation, oil, known under the trade name of "cupping oil," is preferred, as it has more body than the deep solution, and therefore has a better lubricating effect during the cupping operation, which is a heavy one, displacing considerable metal.

3. From experience we find the best lubricant for brass and copper consists of hard soap dissolved in equal parts of warm water and pure lard oil.

Lubricants for Redrawing Shells

Zinc shells should be clean and free from all grit and should be immersed in boiling hot soap water. They must be redrawn while *hot* to get the best results. On some shells hot oil is sometimes used in preference to soap water.

For redrawing aluminum shells, use a cheap grade of vaseline. For redrawing copper shells, use good thick soap water as a lubricant. The soap used should be of a kind that will produce plenty of "slip"; if none such is to be had, mix a quantity of lard oil with the soap water on hand and boil the two together. Sprinkling graphite over the shells just before redrawing sometimes helps out on a mean job.

C. F. Emerson.

Lubricating Composition in Stick Form

When sawing or drilling small copper, brass, or German-silver pieces, with small saws or drills, a lubricant may be prepared as follows: First make a solution of 2 parts of camphor in 4 parts of turpentine. Next melt together 2 parts of pure mutton tallow and 1 part of beeswax. To this melted mixture, add about 5 per cent (by volume) of the camphor-and-turpentine solution and also a few drops of oil of lavender, to offset any offensive odor. This mixture, while hot, is poured into paper tubes about 1/2 inch in diameter and 4 inches long. These are made by winding paper around an arbor, gluing the layers together, and shellacking the outside, when dry. When cold, these sticks should be quite hard, and may be handled without soiling the hands; they are as convenient as a piece of beeswax, and give better results. The stick has the end exposed by removing a narrow ring of the paper and is touched to the revolving cutter; the heat generated by cutting melts the part touching the cutter and lubricates thoroughly. In cases where cleanliness is a primary factor, this method is giving perfect satisfaction.

DRAFTING-ROOM RECEIPTS

Reference tables soon get dirty and torn. To prevent this, pour some lacquer in a shallow tray and dip the paper into it and hang it up to drain and dry. This not only makes the paper dirt-proof, but toughens it as well. MILTON BURGESS.

To Remove Grease from Drawings

Place sheets of blotting paper over and under the stained page, to protect the others. Lay powdered magnesia on the stain and under it; then press over the blotting paper with a hot iron. When the powder is shaken off, the stain is gone. F. L. ENGEL.

To Color Drawing That Is to Be Varnished

When it is required to color or to write with color on a drawing or blueprint that has to be varnished later, mix a little isinglass with the color; this will prevent the color running when the size is applied.

H. T. MILLAR.

To Write on Celluloid

To write on triangles or other instruments made of celluloid, use anhydrous acetic acid. The writing will appear dull on the glossy surface. If colored writing is desired, add some coloring matter to the acid.

J. M. MENEGUS.

To Clean Tracings

Tracings that have become badly soiled from handling or other causes may be easily cleaned by thoroughly sponging the cloth with benzine or gaso-

line. Kerosene will serve the purpose, but it is not so good. It does not injure the cloth in the least, but on the other hand has the effect of re-establishing the color of a much used tracing, and will remove pencil marks perfectly. When some compound has been used on the tracing to remove the ink lines, leaving a sticky and gummy surface, benzine will quickly clean and dry the affected portion, so that it can be worked over again. T. E. O'DONNELL.

To Protect Printed Titles on Tracings

A great many of our railroads and large manufacturing concerns throughout the country are using small printing presses, for the purpose of putting titles on their drawings. After the title has been printed on the drawing, lacquer it over with a very thin coat of French varnish (such as is used by artists). This can be best applied with a chisel-shaped camel's hair brush, equal in width to the height of the letters in the title. A good substitute, where French varnish cannot be obtained, is made by cutting 1/4 ounce of the best grade of white shellac in 1/2 pint of alcohol. As both of these varnishes dry very quickly, the tracings may be used soon after the titles are put on. This treatment will prevent the title from smearing or rubbing off.

E. W. BOWEN.

Preparing Tracing Cloth for Inking

It is a well-known fact that neither the glossy nor the dull side of tracing cloth takes ink readily without being prepared in some manner. The usual way is to sprinkle powdered soapstone or chalk on the tracing cloth and rub it over the surface with a

piece of cloth. A preferable way is to sprinkle the powdered soapstone on the cloth as usual, but rub it in with a blotter instead of a piece of cloth, using a circular motion and considerable pressure; of course, it is necessary to brush away the superfluous powder. The use of a blotter has an abraiding effect and it is just harsh enough to give the cloth a surface which will take the ink readily and still leave the pens unharmed. Repeat this process each morning in case the tracing is not finished the day it is started; the rubbing of the blotter over the lines already inked in does absolutely no harm, and, if anything, makes the lines more dense. A trial of this method will convince the draftsman that the cloth will take the ink better than by any other method.

ROBERT A. LACHMANN.

Chalk Preparation for Tracings

Mix thoroughly one pound of pulverized chalk with one-quarter pound of borax. Rub some of this mixture into a chamois skin, and rub the tracing carefully with this. This preparation is superior to pure chalk.

REX MCKEE.

Erasing Ink from Tracing Cloth

To make a particularly neat erasure on tracing cloth, first clean off as much ink as practicable with the ordinary soft eraser—with or without the use of a shield. Then drop a pinch of tracing-cloth powder on the spot, and rub it with a piece of soft cloth stretched tightly over the tip of the forefinger. This part of the work may also be done with the

aid of a shield, if preferred, but the shield should be an old, thin one.

When all the ink has disappeared, remove the shield and, with a piece of cloth wadded up tightly, rub briskly back and forth over the erased spot, using considerable pressure. This last process puts a gloss on the surface that will take ink perfectly and that will not later pick up dirt. This is particularly true of drawings made on the glossy side of the tracing cloth, where an erasure made in this manner cannot be detected even by reflected light. A smooth, hard surface—such as a celluloid triangle—slipped under the spot to be erased saves time and labor, and seems to give a better job. Tracing-cloth powder that feels a bit gritty when rubbed between the fingers is the proper kind to use. The little extra time required to make an erasure in this way is justified by the better wearing quality of the result, if not by its neater appearance.

F. M. W.

White Writing Fluid for Blueprints—1

A fluid for white writing on blueprints is made of equal parts of sal soda and water. Another fluid, not so good, is made by mixing equal parts of borax and water. Both these fluids must be used with a fine-pointed pen; a pen with a blunt point will not work well. C. W. Morrison.

White Writing Fluid for Blueprints—2

A solution for white marking on blueprints consists of very thick lime water. Have a good deal more lime than will dissolve, and shake up the bottle just before using, and it will not spread. G. V.

White and Red Fluids for Blueprints—1

For marking white lines on blueprints, add to a small bottle of water enough washing soda to make a clear white line, then add enough gum arabic to it to prevent spreading and making ragged lines. To make red lines, dip the pen in red ink and then add a little of the solution by means of the quill.

ED. H. REMDE.

White and Red Fluids for Blueprints—2

In order to make red and white solutions for writing on blueprints, dissolve a crystal of oxalate of potash about the size of a pea in an ink bottle full of water. This will give white lines on blueprints; other potash solutions are yellowish. If this shows a tendency to run, owing to too great strength, add more water and thicken slightly with mucilage. Mix this with red or any other colored ink, about half and half, and writing may be done on the blueprints in colors corresponding to the inks used.

W. H. SARGENT.

Red Fluid for Blueprints—1

The writer has found that ordinary red writing ink with a little sal soda added will give clear distinct marks on blueprints. Very little sal soda is needed. Different grades of ink require different amounts, the right mixture being determined by adding the soda, a few grains at a time, until the ink begins to spread the least bit as it dries. A bright vermilion can be produced, which has the advantage of being visible as soon as it is placed on the blueprint.

MARTIN H. BALL.

Red Fluid for Blueprints—2

For red writing on blueprints, take a piece of common washing soda the size of an ordinary bean and dissolve it in four tablespoonfuls of ordinary red writing ink to make a red fluid. To keep it from spreading too much, use a fine pen and write fast, so as not to allow too much of the fluid to get on the paper, for it will continue eating until it is dry.

H. E. W.

Red Fluid for Blueprints—3

To make changes and corrections on blueprints, use a solution of sodium carbonate and water, with a little red ink mixed in. This gives a very pleasing reddish or pink color which is very noticeable. The amount of sodium carbonate used depends upon the surface of the blueprint paper, as some coarse-grained papers will look better if less soda is used, and vice versa. However, the amount of powdered soda held on a five-cent piece dissolved in a bottle of water (Higgins ink bottle) gives very good results.

R. F. Kiefer.

Retouching Blueprints

An excellent solution for retouching or marking in details on blueprints can be prepared according to the following receipt. The solution consists of 75 grains of potassium oxalate dissolved in 1 ounce of water. If the solution is too thin and watery, it may be thickened by adding some kind of a gum preparation. It can be applied with a pen, as ordinary ink. The blue background is removed very rapidly by the solution, but it is important that the

print be immediately washed, as the solution has a tendency to soak into the pores of the paper and blur the lines.

T. E. O'DONNELL.

Varnishing Drawings or Blueprints

Drawings and blueprints which are to be varnished before sending out into the shop may be treated in the following manner: Dissolve gelatin in water and coat the drawing, using a soft brush. After this coating has thoroughly dried, give the drawing a coat of common clear varnish.

Mounting Blueprints—1

In mounting blueprints, good results have been obtained by using tin, galvanized iron or straw-board sheets. These sheets should be about one inch larger each way than the print, thus allowing a margin of half an inch. After applying common library paste to the tin or sheet, making certain that the paste is not lumpy, lay the blueprint in water and hang up to partially dry. When about as dry as a sponge that has had the water squeezed out of it, lay it on the metal and carefully smooth out the wrinkles by hand and then set aside to dry. The print will shrink slightly in drying, and will therefore be very smooth. Finally, give one coat of white shellac, and in a few minutes it is ready for use. Previously, considerable trouble has been experienced through wrinkled prints, but this method has entirely overcome that difficulty.

E. H. R.

Mounting Blueprints—2

The following method of mounting blueprints for shop use has been used by us and has proved satis-

factory: To mount the print, cut a piece of No. 25 junkboard to a size that will allow about 1/4 inch margin around the blueprint. The junkboard is then backed with a sheet of cheap white paper, the edges of which are folded over on the face of the board and extended about 1/2 inch in on all sides. Now fasten the blueprint to the face of the board, and give it a good coating of white shellac. The object of the paper backing is to keep the mount flat. We have hundreds of blueprints mounted in this manner which have been in constant use, and have given perfect satisfaction. By using white shellac instead of paste, a new print may be placed over an old one, which will not crack or loosen, as is usually the case if paste is used.

H. D. AYLSWORTH.

Mounting Blueprints—3

Common strawboard is a good and cheap material for mounting prints. For prints 14 x 20 inches or smaller, use No. 20 (20 sheets 26 x 38 inches to the bundle), which is a scant 1/8 inch thick. Trim the print 1/2 inch larger all around than the cardboard, notch the corners of the print, and fold over and paste the 1/2 inch edges on the back of the card. Use stiff library paste rubbed onto the edges of the card with a flat stick or with the finger, and work the print down tight to the card with a putty knife having a smooth rounded edge. The stiff paste sets quickly, and holds the edges of the print, and there is no moisture to stretch the face of the print out of shape. This leaves the print held to the cardboard by the back edges only, the face or printed side simply lying close to the card. Prints so mounted

answer all requirements for shop use. They are easy to mount, light to handle, stack nicely in racks, and look neat. When they get dirty or torn, run a knife under the face side, cut the print off, and paste on a new one.

F. A. DEW.

Mounting Blueprints—4

Our company discarded cardboard-mounted prints and use No. 28 galvanized iron sheets, which is probably as thin as can be used without warping. The sheets are made 5/8 inch larger all around than the print size, including a 1/4 inch lap, which not only stiffens the sheets, but also makes the edges somewhat easier on the hands.

We make a paste of flour and water about as thick as that used by paper hangers, and cook it in the patternmaker's electric glue heater. The back of the print is thoroughly covered with paste, but this must be applied quickly, so as not to let the print get more wet than necessary; if not done quickly enough, a chemical action takes place between the water in the paste and the galvanized iron, resulting in spots on the prints. The print is then smoothed down well with the hands or with a rubber roller, taking care to get most of the wrinkles out, and incidentally working all the surplus paste out from under the print, after which it is thoroughly dried. In summer, we dry our prints in the sun; in winter, we put them near the radiator.

After drying, the varnish is applied; common yellow shellac varnish answers the purpose very well, but the white shellac varnish is preferable. To remove the prints, let them soak in water an hour or so, when they can be taken off with ease. For clean-

ing, the mounted prints can be washed in benzine or soapy water. To use an old sheet which has been previously mounted with shellac, burn all the varnish off before applying the paste; otherwise, the print will not stick, and it is likely to become spotted. We have about 1400 mounted prints in the factory, some of which have been in use for fifteen years, and find this method better than any other. D. U. B.

Mounting Blueprints on Celluloid—1

A method of mounting blueprints on celluloid that we have used with success is to saturate the surface of the celluloid with wood alcohol, then place it on the blueprint, and hold it flat by a heavy book until dry. This causes the celluloid to adhere firmly to the blueprint.

Mounting Blueprints on Celluloid—2

Paper can be made to adhere to celluloid by the use of amyl acetate. The surface of the celluloid is covered with the amyl acetate, and as soon as the surface becomes somewhat sticky, the blueprint is applied. G. I. Ware.

Mounting Blueprints on Celluloid—3

To make blueprints adhere to celluloid, use celluloid cement. This can be easily prepared by dissolving celluloid scraps in acetone, amyl acetate or any other suitable solvent. Wm. Martins.

Mounting Blueprints on Celluloid—4

We attach blueprints of our telephone numbers to celluloid in the following manner: First the blue-

prints are placed between two thin sheets of celluloid, and then the celluloid sheets are put between heated plates until they are sufficiently hot for the two sheets to adhere to each other. The adhesion of the sheets is so perfect as to appear like a single sheet, and the blueprint is protected on both sides.

E. T. SMITH.

Mounting Blueprints on Celluloid—5

If the blueprint is small, the use of collodion will be satisfactory; but if the prints are large, it may prove too expensive. The collodion must be applied quickly, as it dries rapidly, and if a large surface is to be covered, it must be spread on with a brush. Ether is the solvent employed in preparing collodion and must be used in cleaning the brush—an operation which is rather expensive.

If the blueprint is a small one, the collodion can be applied with a metal or glass rod spreader. The print and the celluloid are placed together very quickly, and held together for a few minutes under a slight pressure, such as is obtained by using a book for a weight. It should be borne in mind that collodion is inflammable and explosive, being somewhat similar to guncotton or nitroglycerin. A little experimenting may be required to obtain the desired results. As the collodion is transparent, the blueprints may be mounted either face up or face down on the celluloid.

CHARLES A. LOYDA.

To Restore Overexposed Blueprints—1

Blueprints that have become burned or overexposed, may be saved by the use of the following formula: Make a saturated solution of bichromate of

potash, and keep a supply on hand in the blueprint room. If a print becomes overexposed, wash it in the usual manner in a tank or tray of water, after which place it in another tray, which should contain a mixture of two parts water to one part of the saturated solution of bichromate of potash. Allow the print to remain in the tray containing the solution until it shows a deep blue color and the white lines are clearly defined (which requires but a few seconds), after which the print should be thoroughly washed and rinsed in clear water. The proportion of the bichromate of potash may be increased or diminished as the occasion requires. This solution also acts equally as well when applied to whiteprints made from vandyke negatives. Prints, as well as expense and time, may be saved by the use of the above solution. J. C. Hassett.

To Restore Overexposed Blueprints—2

Blueprints are never so overprinted that they cannot be reduced to a suitable tone by a slightly alkaline bath of borax, bicarbonate of soda, washing soda, or ammonia. Blackline, or "ink" process paper, is usually lost if slightly overprinted.

Sepia prints, when much overprinted, can be saved by washing in a very weak solution of hyposulphite of soda, which bleaches away the image before it can become fixed by the usual preliminary wash in plain water. The hyposulphite solution is so energetic that it will bleach down the darkest of sepia prints if not previously put in water. Purple tones are obtained, after washing, by treating with any gold-toning bath.

Charles R. King.

Solution for Cleaning Blueprints

Dissolve enough bichromate of potash in water to color the water a deep orange—or about one tablespoonful to eight gallons of water. Wash the blueprints in clear water before and after using the solution. E. Ray Croft.

Waterproofing Blueprints

To prevent the annoyance occasioned by having blueprints discolored by rain, drippings of mines or other similar exposures, a very simple method of waterproofing them may be effected as follows. The waterproofing medium is refined paraffin. To apply, immerse in the melted paraffin, until saturated, a number of pieces of an absorbent cloth at least a foot square. When withdrawn and allowed to drain for a few moments they are ready for use. Lay one of the saturated sheets on a smooth surface, place the dry print on top of it, and then lay a second sheet of the saturated cloth over it. Iron the top cloth with a moderately hot flat-iron. The paper immediately absorbs the paraffin until saturated, becomes translucent and highly waterproofed, owing to the smooth glossy surface, which is the result of the ironing. The lines of the print will be intensified, and the paper left perfectly smooth and easy to handle. T. E. O'Donnell.

To Tone Blueprints

After washing the blueprint in the usual manner, immerse it for half a minute or less in a solution made by dissolving a teaspoonful of potassium bromide crystals in one-half gallon clear water. Then

rinse the print in clear water and hang it up to dry. A galvanized iron or japanned tray may be used for the solution. Prints may be much overprinted and yet give beautiful clear whites and extremely deep blues, easily seen by the workman and a delight to the directors; the latter, especially, because the solution is quite inexpensive, and can be used over and over again until an objectionable precipitate forms. F. J. SCHAUFELBERGER.

To Bleach Blueprints

It is occasionally necessary to bleach blueprints when it is desired to make drawings for photographic reproduction. Blueprints are sometimes so faded that it is impossible to trace them, in which case ink the lines of the blueprint and then bleach out the blue, leaving the black lines on the white ground. The process of bleaching is extremely simple.

Use about 1 gallon lukewarm water and 1/2 pound bicarbonate of soda. This proportion is not exact, and has to be used with caution. When in doubt, prepare a little solution and make a test of a small piece beforehand, as it will be found that some prints will not bleach as others do. Do not allow the inked-in prints to remain in the solution any longer than is absolutely necessary, for no matter how waterproof the ink may be, it is impossible to keep it from running a little. Freshly made blueprints, that is, those not more than a few months old, work best. As soon as the print is bleached, take it out of the solution by the corners, being careful not to touch the ink lines. Too much soda is harmful, as it deposits white dust on the lines. This, however, can be removed by re-immersion in clean water. FRED DIBELIUS.

Brownprints from Blueprints

The following solution will change the color of blueprint paper to a dark brown: Borax, 2 1/2 ounces; hot water, 38 ounces. When cool, add sulphuric acid in small quantities until blue litmus paper turns slightly red, then add a few drops of ammonia until the alkaline reaction appears, and red litmus paper turns blue. Then add to the solution 154 grains of red crude gum catechu. Allow this to dissolve, with occasional stirring. The solution will keep indefinitely. After the print has been washed in the usual way, immerse it in the above bath for a period of a minute or so longer than necessary to obtain the desired tone. An olive brown or a dark brown is the result. JOHN B. SPERRY.

To Make Vandyke Prints Transparent

To a pint of best grade gasoline, add as much paraffin as the gasoline will readily dissolve, and spread this solution evenly over the print with a soft brush; wipe dry with a piece of white cotton rag and print in the usual manner. Vandyke prints treated in this way will be more transparent and require only about two-thirds the usual time to print. E. W. BOWEN.

ETCHING SOLUTIONS

Names or designs can be etched upon steel by the acid method. It is first necessary to apply a thin, even coating of some material such as beeswax, which will resist acid. The lettering or design is then marked in the wax with a sharp-pointed scriber, thus exposing the steel to the action of an acid which is applied afterwards. This acid or etching fluid may need to be varied somewhat, depending upon the exact nature of the steel. Various receipts follow:

Different Etching Solutions

Soft Steel.—Nitric acid, 1 part; water, 4 parts.

Hard Steel.—Nitric acid, 2 parts; acetic acid, 1 part.

Deep Etching.—Hydrochloric acid, 10 parts; chlorate of potash, 2 parts; water, 88 parts.

Iron and Steel.—Hydrochloric acid (full strength).

Brass.—Nitric acid. Another solution for brass follows: Nitric acid, 16 parts; water, 160 parts. Dissolve six parts potassium chlorate in 100 parts of water, then mix the two solutions and apply.

Bronze.—Nitric acid, 100 parts; muriatic acid, 5 parts.

Copper.—A mixture containing 2 parts of nitric acid and 1 part sulphuric acid.

Silver.—Nitric acid, 3 parts; water, 1 part.

Gold.—A mixture containing 1 part of nitric acid and 3 parts of hydrochloric acid. This mixture should be prepared just before being applied and should be used warm, under a hood or fume closet

Platinum.—The same mixture as used for gold.

Lead.—Nitric acid.

Aluminum.—A 10 per cent solution of caustic soda or potash.

Zinc.—A mixture containing equal parts of hydrochloric acid and water, used warm.

Glass.—Hydrofluoric acid. The article may be immersed in the liquid acid for a few minutes or it may be exposed to the fumes from five to fifteen minutes. Extreme caution should be used in handling this acid, using rubber gloves for the hands and a lead or hard rubber container for the acid. Contact with the skin will cause severe burns, and the action seems to be continuous, producing burns far more severe than those caused by the mineral acids.

All of these acids may be used full strength and will act instantly, but if the etching is to be of considerable depth most of them may be diluted with water before applying. This will require more time, but will produce a cleaner cut. The exception to this is the mixture for gold and platinum, which must always be used full strength and applied as warm as the melting point of the wax will permit.

The action of etching fluids on steels varies somewhat according to the composition, high-carbon and alloy steels being acted upon more slowly than low-carbon steel or wrought iron. Etching fluids that work successfully on low-carbon steel may not work well on high-carbon steel or cast iron. The usual difficulty is that the carbon liberated by the etching fluid settles to the bottom and prevents further action. This difficulty can be overcome, however, by frequently renewing the acid and cleaning out the carbon deposit so that the fresh acid will come into direct contact with the metal.

Etching Solution for Steel—1

The following receipt for a fluid for etching steel will be found satisfactory, both for frosting effect and deep etching. Mix 1 ounce sulphate of copper, 1/4 ounce alum, 1/2 teaspoonful of salt (reduced to powder), with 1 gill of vinegar and 20 drops of nitric acid. This fluid can be used either for etching deeply or for frosting, according to the time it is allowed to act. The parts of the work which are not to be etched should be protected with beeswax or some similar substance. S. C.

Etching Solution for Steel—2

The following solution will be found excellent and reliable either for very deep etching upon steel, or for the purpose of producing beautiful frosted effects upon the surface. Mix together 1 ounce sulphuric acid, 1/4 ounce alum, 1/2 teaspoonful salt, 1/4 pint acetic acid or vinegar, and 20 drops concentrated nitric acid. The etching effect produced by this solution depends upon the length of time it is allowed to act upon the metal. It is applied in the same way as ordinary etching acid. T. E. O'Donnell.

Etching Solution for Steel—3

Many receipts for etching acid to be used on steel call for two-thirds muriatic acid. The object of the muriatic acid is simply to remove the grease and foreign substance from the steel, and if only enough muriatic acid is used to accomplish this purpose, the etching acid will work better and quicker. Use two-thirds nitric to one-third of muriatic acid.

George W. Smith.

Etching Solution for Steel—4

The etching solution made by the following formula has an advantage over other etching solutions in that it will not rust the most highly polished steel, and it is not in any way injurious to the hands or clothing. Mix 6 ounces distilled water; 4 ounces sulphate of copper, 4 ounces chloride of sodium (common salt); 1 dram sulphate of zinc; 1/2 dram sulphate of alum. The solution is applied in the following manner: The piece to be marked is covered with melted beeswax, and the inscription to be etched is marked through the wax with a fine pointed tool, leaving the wax undisturbed save where the marking is to appear. The markings are then filled with the fluid and allowed to stand for three hours. The result will be a very sharp and distinct lettering.

L. MEYERS.

Etching Solution for Steel—5

First, heat an iron or an old pillar file with a smooth side, and with it spread a thin, even coat of beeswax over the brightened surface to be etched. With a sharp lead pencil (which is very much preferable to a scriber), write or mark, as wanted, through the wax so as to be sure to strike the steel surface. Then daub on with a stick some etching acid made as follows: 3 parts nitric acid; 1 part muriatic acid. If a lead pencil has been used the acid will begin to bubble immediately. Two or three minutes of the bubbling or foaming will be sufficient for marking; then soak up the acid with a small piece of blotting paper and remove the beeswax with a piece of waste wet with benzine; and if the piece be small enough,

dip it into a saturated solution of sal soda; or if the piece be large, swab over it with a piece of waste. This neutralizes the remaining acid and prevents rusting, which oil will not do.

If it is desired to coat the piece with beeswax without heating it, dissolve pure beeswax in benzine until of the consistency of thick cream, and pour onto the steel and spread it evenly by rocking or blowing, and lay it aside to harden; then use the lead pencil, etc., as before. This method will take longer. Keep work away from the fire or an open flame.

A. S. GUN.

Etching on Copper

For an acid-resisting ground, use a mixture of 2 ounces white wax to which, when melted, is added 1 ounce gum mastic in powdered form, a little at a time, until the wax and gum are well mixed. Then, in the same way, add 1 ounce powdered bitumen. When this is thoroughly mixed, add to it 1/2 of its volume of essential oil of lavender. This should be well mixed and allowed to cool. The paste can be applied with a hand roller, and if it is too thick, can be made to flow easier by adding a little more oil. When the paste is applied to the copper plate, expose it to a gentle heat, in order to expel the oil of lavender. For etching acid, use a mixture of 5 parts of hydrochloric acid, 1 part of chlorate of potash and 44 parts of water. The water is heated and the potash added. The acid is added first when the potash is fully dissolved. This mixture is used by immersing the whole object to be etched, the object, of course, first being covered on all sides by the acid-resisting ground.

OLIVER E. VORIS.

Etching Brass—1

The first step in etching is to see that the parts that are to be etched are carefully ground and polished. The only cleaning which will be found necessary can be satisfactorily done by wiping the work with a dry rag. The next step is to heat the work and then dip it into molten paraffin, after which it is removed and allowed to stand until cool. The pattern which is to be etched is marked in the paraffin in order to expose the metal.

The etching is done with undiluted nitric acid. If the etched lines are to be very deep, the work should be immersed in lukewarm water occasionally to remove the copper nitrate which forms in the etched lines. This will prevent the lines from spreading. It is only necessary to leave the work under water for a few seconds in order to remove the copper nitrate.

The preceding instructions also apply to etching steel, with the important exception that the etching solution is composed of one part of nitric acid and one part of hydrochloric acid. The paraffin may be removed from the work by first dipping it in boiling water and then in cold water; this treatment causes the paraffin to contract and peel off.

GEORGE GARRISON.

Etching Brass—2

For etching brass castings, clean the work with gasoline and place it in clean boiling water. A pot of beeswax is melted and kept at a temperature of from 200 to 250 degrees F. by standing it on a gas plate or some other heater which will retain the desired temperature. After the work has been washed,

the surface to be etched is painted with wax and the work is then hung up to cool. The surplus wax will drain off and some sort of pan should be provided to catch the drippings. This process leaves a very thin coat of ground that adheres firmly to the metal.

The following is a very satisfactory formula for an etching solution: Nitric acid, 16 parts; muriatic acid, 4 parts; water, 100 parts. Dissolve 6 parts of potassium chlorate in 80 parts of water. The two solutions produced in this way are then thoroughly mixed and allowed to stand for a few minutes until the gases have escaped. The solution is then stirred, after which it is ready for use. W. C. Betz.

Wax Coating for Etching

In using the chemical etching process for etching names or designs on steel, etc., the proper application of the ground which is used to protect the parts from the action of the corroding fluid is very important. Some form of wax on which etching fluid has no action is generally used for this purpose. For general purposes, beeswax of the proper consistency is excellent, and it can be applied easily in any desired thickness. Before applying the wax, it is important that the surface be thoroughly clean and absolutely dry, and the difference in temperature between the wax and the article to be etched should be slight. If it is necessary to dip the piece into melted wax, the article should be kept immersed for a few moments until it acquires the same temperature as the molten wax. If there is a film of oil on the surface to be coated, the wax will cover it but not adhere, and in consequence the etching fluid will run under the wax and produce a smear

or blur. The same effect is produced by moisture, except that in this case the blur is likely to be worse, as there is an affinity between water and etching fluid which causes spreading.

Etching Resist and Solution

The following gives a formula which has been successfully used for etching operations: The ground or "resist" is compounded as follows: Melt 2 ounces of white wax and add to it 1 ounce of gum mastic in powder, the gum mastic being added a little at a time and stirred thoroughly so that a uniform mixture is obtained. Then add 1 ounce of bitumen powder in the same way. This mixture is dissolved in chloroform or oil of lavender, when it is ready for use.

The formula for the etching solution is as follows: Hydrochloric acid, 100 grams; chlorate of potash, 20 grams; water, 880 grams.

In compounding the etching solution the water is heated, after which the chlorate of potash is added. After the chlorate of potash is entirely dissolved, the hydrochloric acid is added to the solution.

H. N. Hammond.

GLUES FOR WOODWORKING

The glues used for woodworking come in two forms and many grades. The liquid or cold glue is very handy for small work or in cases where the assembling must be done slowly. It is slow-setting, and not as strong as the hot or cooked glue that is in almost general use. Cooked glue is an animal glue and comes in flake, sheet, and pulverized form. A good quality of flake or sheet glue is rather thin and of amber color. The pulverized form is quickly prepared, but it is hard to determine the quality when it comes this way, as the grinding changes the appearance, and it is an easy matter to substitute inferior glue. Freshly cooked glue is strongest, and with each successive heating and cooling its strength becomes less; therefore, it is a good plan to gage the amount required for each day's work as closely as possible, and so manage to have fresh glue constantly on hand. When the glue is of good quality, it may be drawn out into thin threads.

Classes of Glues for Wood

The glues that are adapted for gluing wood, according to a report of the Forest Products Laboratory, U. S. Forest Service, Madison, Wis., may be conveniently divided into five general classes as follows:

1. Animal glues, which are made from the hides, hoofs, horns, bones, and fleshings of animals, mostly cattle. These glues come in dry form, and must be mixed with water and melted.

2. Casein glues, which are made from casein, lime, and certain other chemical ingredients. They are commonly sold in prepared form, requiring only the

addition of water, but may be mixed by the addition of the separate materials to the water.

3. Vegetable glues, which are made from starch, usually cassava starch, and sold in powdered form. They may be mixed cold with water and alkali, but heat is commonly used in their preparation.

4. Blood-albumin glues, which are made from soluble blood albumin, a product recovered from the blood of animals. These glues must be mixed just before use, since they deteriorate rapidly on standing.

5. Liquid glues, which are commonly made from the heads, skins, bones, and swimming bladders of fish. Some liquid glues are made from animal glue and from other materials. They come in prepared form ready for immediate use.

Animal Glue

Animal glue, frequently referred to as "hot glue," has been in use a long time, and is familiar to all woodworkers. The principal desirable properties of animal glue are its great strength and reliability in the higher grades, its free-flowing consistency, and the fact that it does not stain wood. So far no glue has been found by the woodworking industry to be as suitable as animal glue for hand-spreading on irregular shaped joints, although a cheaper glue would be very desirable. The price of animal glue is the chief factor that limits its use. The fact that it is not highly water-resistant is occasionally a drawback.

Casein Glue

Casein glue has been used commercially for a much shorter time than animal glue, and its possibilities

and limitations are not so well known. It has sufficient strength for either veneer or joint work. It is used cold, and when properly mixed it can be spread with a brush. The property most featured is its high water-resistance, which makes it suitable for gluing articles to be used under moist conditions. Not all casein glues are water-resistant, however; there are some on the market which are made to compete with vegetable glue, and for which no great water-resistance is claimed. Among the disadvantages of casein glues are their tendency to stain thin veneer and the relatively short working life of some kinds. It is claimed that this trouble has been overcome to a certain extent in some glues. They are somewhat harder on tools than animal and vegetable glues.

Vegetable Glue

Vegetable glues have found wide use in recent years because they are cheap, can be used cold, and remain in good working condition, free from decomposition, for many days. They are extremely viscous, and it is not practicable to spread them by hand. Their lack of water-resistance and the fact that they usually cause staining in thin fancy veneer are factors limiting their use. They set relatively slowly, and for this reason are not so well adapted for joint work.

Blood-albumin Glue

Blood-albumin glue has shown notably high resistance to moisture, especially in the boiling test. This makes it particularly suitable for gluing plywood

which is later to be softened in hot water and molded. The production of molded plywood articles has been very limited, but it offers a good field for future development. In the past the chief drawback to the use of blood glues has been the necessity for hot-pressing, but tests have shown that a highly water-resistant blood glue may be developed which can be cold-pressed successfully.

Liquid Glue

Liquid glues are, in general, similar in properties to animal glue. Some brands are quite equal in strength to good joint glues, but other brands are very weak and unreliable. Their great advantage is that they come in prepared form, ready for immediate use. This makes them particularly suitable for patch work and small gluing jobs. The factors that limit their use are their high price, their lack of water-resistance, and the difficulty in distinguishing between good and poor brands.

Veneer and Joint Glues

Generally speaking, present vegetable and blood-albumin glues are veneer glues, while animal and casein glues are used both as veneer and as joint glues. As between animal and casein glue for joint work, if freedom from staining is important, animal glue is preferable; if water-resistance is of importance, then a casein glue should be selected. Because of the necessity of heat in the preparation and use of animal glue, the casein cold glue will probably be favored if both glues are otherwise equally well adapted.

Preparation of Glue

In preparing glue, it should be allowed to stand overnight in clean, cold water, which causes it to swell greatly. The water should then be poured off, and the glue dissolved in hot water. The glue receptacle should not be heated by contact with the fire, as lumps of partially dissolved material may adhere to the bottom and become charred. Instead, the vessel containing the glue should be placed inside a larger vessel containing hot water. Prolonged heating injures the adhesive qualities of glue and increases its tendency to foam.

Glues Which Resist Moisture

A glue cement that resists moisture is made by mixing with the least possible quantity of water 1 part glue, 1 part rosin and 1/4 part red ochre.

Another glue that resists moisture is made of one pint glue melted in two quarts skimmed milk. Add powdered chalk to make it stronger.

A marine glue is made of one part of India rubber, 12 parts naphtha. Heat gently, mix and add 20 parts of powdered shellac. Pour out on a slab to cool. When used it has to be heated to about 250 degrees F.

A. L. Monrad.

To Prevent Glue Cracking

A useful fact to know in regard to glue, when using it on furniture or other work that will be exposed to a very dry atmosphere, is that a small addition of chloride of lime will tend to prevent the glue drying out and cracking. The chloride of lime is strongly hygroscopic and constantly attracts enough

moisture from the atmosphere to keep it moist. Use about one-fourth ounce of chloride to one quart of glue. M. E. CANEK.

To Make Liquid Glue

Take one quart soft water and 2 pounds of pale glue; dissolve in a covered vessel by the heat of a water bath, cool, and add gradually 7 ounces of nitric acid (specific gravity 1.335). This glue is very strong and will not gelatinize. C. S.

To Waterproof Glued Joints

To render glued joints waterproof, rub common chalk on the surface of the wood where the glue is to be applied, and then coat with ordinary glue in the usual manner. The chalk will protect the glue from moisture, so that the joint will hold as well after being soaked in water as before.

W. S. LEONARD.

Causes of Weak Joints

Weakness in glued joints may be caused (1) by allowing the glue to become too cold before applying pressure; (2) by using glue that is too thin and is squeezed out of the joint; or (3) by allowing the glue to dry too much before applying pressure. These three mistakes are the most common ones in gluing practice, and they are known as the "chilled joint," the "starved joint," and the "dried joint," respectively.

To Obtain Strong Joints

Strong joints may be obtained by changing either pressure, assembly time, or temperature, these being

the three most important factors in the gluing operation when animal glue is used. Thus, a good joint can be made from chilled glue by increasing the pressure, or the glue may be kept from becoming chilled and a good joint obtained if either the assembly time is decreased or the room temperature increased. If the glue is thin, starved joints may be avoided by decreasing the pressure, although such practice is not always recommended. Better average results are obtained if the consistency of a thin glue is increased either by increasing the assembly time or by decreasing the room temperature.

Pressure Required in Gluing

No amount of pressure will produce a good joint from dried glue, but by decreasing either the assembly time or the temperature to which the wood is subjected, a good joint can be made before the glue has dried out. Assembly time, room temperature, and wood temperature are chief among the factors affecting the consistency of an animal glue at the moment pressure is applied. Pressure, then, must be adjusted to suit the consistency of the glue, the thicker mixture requiring the greater pressure. The foregoing information on gluing practice is based upon a report of the Forest Products Laboratory, United States Forest Service, Madison, Wis.

HEAT-TREATMENT OF STEEL

In hardening steel it is essential to heat steel uniformly and to as low a temperature as will give the required degree of hardness. If the temperature is not uniform throughout the piece, this causes internal stresses; and if the temperature is too high when the steel is quenched, the grain of the steel will be too coarse. Liquid baths tend to heat the steel uniformly and the temperature cannot exceed the temperature of the bath. The steel while submerged is also protected against the oxidizing action of the air, which causes the formation of scale. Uneven heating is the cause of most defects in hardening steel.

Effect of Quenching Baths

Tools quenched in baths of different composition will vary in hardness. This is due mainly to the difference in the heat-dissipating power of the different baths. Thus, a tool hardened at the same temperature in water and brine will come out harder when quenched in brine; the greater the conductivity of the bath, the quicker the cooling.

Water for hardening tool steel should be soft; entirely different and very unsatisfactory results will be obtained when using hard water. While different quenching oils show less difference in the results obtained, vegetable and animal oils will give somewhat different degrees of hardness, depending upon the sources from which they are obtained. One cannot be too careful in the selection of water, as it is likely to contain many impurities. If it contains greasy matter, it may not harden steel at all;

whereas, if it contains certain acids, it will be likely to make the tools quenched in it brittle and even crack them.

To Harden Drills for Cutting Glass

To harden drills for cutting glass, dissolve zinc in muriatic acid to saturation, then reduce the solution by adding an equal volume of water. Dip and use without tempering. E. W. NORTON.

Extreme Hardness in Steel

The steel to be hardened should be immersed in a mixture of 4 parts of water, 2 parts of salt, and 1 part of flour. To get the steel thoroughly coated, it should be slightly heated before dipping in the composition. After dipping, it is heated to a cherry red and plunged in soft water. This will make the steel harder than if simply heated and dipped in water. S. C.

Hardening Solution—1

To make a hardening solution for metal-cutting tools, mix saltpeter, 2 ounces; sal-ammoniac, 2 ounces; alum, 2 ounces; salt, 1 1/2 pounds; and soft water, 3 gallons. Keep the solution in a stone jar, for it will eat a wooden tub and rust an iron pot. Do not draw the temper, but only warm the tools enough to relieve the hardening strains. It is also well to rinse the tools well in water, for if this is not done, the solution will rust them.

Hardening Solution—2

To make an excellent hardening solution, mix pure rain water and salt strong enough to float a raw

potato, and to twenty gallons of the brine add three pints of oil of vitriol. Tool steel may be hardened at a surprisingly low heat in this solution, a very great advantage, of course, when hardening difficult shapes. The solution, however, has one slight disadvantage in that it causes the steel to rust quickly unless the steel is thoroughly scrubbed in strong hot soda water immediately after hardening. Tools hardened in this solution should come out of the bath a beautiful silver-gray color, and if there are any black spots they are likely to be soft.

I. W. ANTANO.

Hardening Solution—3

The following hardening solution will be found suitable for hardening small tools, such as taps, dies, etc. Pieces hardened in this solution are made extremely tough and will withstand considerable pressure. The solution is as follows: To 15 gallons of water add 1 pound of cyanide of potassium, 6 pounds of saltpeter, 2 pounds of common lime, 3/4 ounce of permanganate of potash. Distilled water, if it can be obtained, should be used; but rain water, if pure and clean, will also answer the purpose, although distilled water is better. Before dipping the tools they should be heated to a cherry red, and when dipped in the bath they should be kept moving, so that they will harden uniformly. It is not necessary to draw the temper after hardening.

JOS. R. WEANER.

Hardening Solution—4

An excellent compound for hardening and tempering steel consists of 10 gallons of soft water, 5 tea-

cups of salt, 6 ounces saltpeter, 12 teaspoonfuls of powdered alum, and 1 teaspoonful corrosive sublimate. We have tempered flat cutters, Acme and U. S. standard taps, counterbores, reamers, etc., to our entire satisfaction, without drawing the temper in any of them.

H. S. HINDMAN.

Hardening Solution—5

The following receipt will be found specially good for hardening cold chisels, center punches, flat lathe drills, etc., and in fact almost any tool not having irregular forms or thin cutting edges. To 6 quarts of good clear rain water add 1 ounce of corrosive sublimate and 2 pints common salt. Stir until thoroughly dissolved. This compound seems to both harden and toughen steel; the tools are dipped and drawn in the usual manner.

HERRMANN G. KROEGER.

Compound to Protect Delicate Parts

In hardening small tools, some of the more delicate and essential parts of the tool to be tempered are very apt to be overheated and burned unless extraordinary care is exercised. The following compound can be used to prevent overheating of such small delicate instruments during the process of tempering. Dissolve 2 ounces of pure castile soap in enough warm water to make a thin paste, and add to it the contents of a five-cent package of lamp black, mixing it well into a stiff paste. This must be kept securely sealed in a can. To use the compound, slightly warm the small tool or object that is to be hardened, and smear the paste all over it. When dry, heat and quench in the usual way. As

the paste is removed by the bath, the work will be clean enough to observe the color in tempering.

T. E. O'Donnell.

Tempering Solution for High Heats

A tempering solution used for high heats may be composed of two parts Chili saltpeter and one part nitrate of soda. This tempering solution is used only at high temperatures, as it becomes solid at about 500 degrees F. It is used in place of tempering oils, as they often thicken after short use, and will flash or ignite at about 600 degrees F., and often at a lower temperature. It should be used in connection with a tempering furnace, the heat being gaged by a thermometer. The thermometer should be removed when the day's work is over. At night, two iron plugs, with a fairly liberal taper per foot, and long enough to reach from the inside bottom of the tank containing the bath to about four inches above the top of the solution, should be placed vertically with the small end of the taper down, and some little distance apart. These should be permitted to stay in the solution when it solidifies. On the following morning, these iron plugs should be unscrewed and removed. The holes left in the solidified solution by these plugs afford an escape for gases that form in reheating the bath. E. S. Wheeler.

Hardening High-speed Steel without Pitting

The following method of hardening will be found satisfactory for such tools as milling cutters, forming tools for automatics, and other tools of a similar nature made from high-speed steel that are required to have smooth unpitted surfaces. First, preheat

the work in a low-temperature furnace to from 1500 to 1550 degrees F., raising the temperature slowly. Remove to a high-temperature furnace which is heated to from 1950 to 2250 degrees F., according to the hardening heat recommended by the makers of steel, and heat quickly to the hardening temperature. When the hardening temperature is reached, remove the work immediately and quench in a salt bath, heated to from 1200 to 1300 degrees F., consisting of the following ingredients: Calcium chloride, 40 per cent; sodium chloride, 40 per cent; and ferrocyanide of potassium, 20 per cent. Leave the work in the bath until the steel assumes the temperature stated, then remove and cool in oil at from 350 to 400 degrees F. When removed from this bath, the work should be washed in boiling soda to remove the salt. High-speed steel, heated and treated in this way, will be found to give excellent service, and it will come from the bath clean and unpitted.

WILLIAM C. BETZ.

Mixture for Hardening Spiral Springs

The following oil bath mixture gives excellent results for hardening spiral springs: Two gallons best whale oil, 2 pounds Russian tallow, and 1/2 pound rosin. Boil the tallow and the rosin together until dissolved; add the whale oil and stir up well, and then it is ready for use. W. R. BOWERS.

To Harden Steel without Scaling

Articles made of tool steel and polished may be hardened without raising a scale, thereby destroying the polish, by the following method: Prepare equal parts in bulk of common salt and fine cornmeal,

well mixed. Dip the article to be hardened first into water, then into the mixture and place it carefully into the fire. When hot enough to melt the mixture, take from the fire and dip or roll in the salt and meal, replace in the fire and bring to the required heat for hardening. Watch the piece closely, and, if any part of it shows signs of getting "dry," sprinkle some of the mixture on it. The mixture, when exposed to heat, forms a flux over the surface of the steel which excludes the air and prevents oxidation, and when cooled in water or oil comes off easily, leaving the surface as smooth as before heating. Borax would possibly give the same result, but is sometimes difficult to remove when cold.

E. C. Noble.

To Harden Fine Dies

To successfully harden dies for fine work, such as are used by jewelers and others, be careful to have the surface free from all grease or oil, pack face downward in a mixture of equal parts of finely powdered hardwood charcoal and charred bone. Dip in salt water and draw temper to 450 degrees F.

Hardener.

To Prevent Scale on Dies—1

A good way to prevent scale on dies, when hardening, is to dip them in water before they are heated and then put them into dry salt, letting all the salt that will cling to them. After this the pieces are heated and immersed in brine, as usual. The scale or crust of salt will fall off in the water. The piece so treated will have the appearance of a piece which has been heated in cyanide. Donald Baker.

To Prevent Scale on Dies—2

It is possible to prevent the formation of any scale in the impression of fine jewelers' dies and the like, and retain the finished brilliancy of surface, by applying a mixture of powdered ivory black and sperm oil, mixed to the consistency of paste. It is only necessary to apply a thin coat. HARDENER.

To Remove Burnt Oil from Steel

To remove excess oil from parts that have been hardened in oil, place the articles in a small tank of gasoline, which, when exposed to the air, will dry off immediately, allowing the part to be polished and tempered without the confusing and unsightly marks of burnt oil. H. C. BACHMANN.

To Prevent the Sticking of Hot Lead—1

To prevent molten lead from sticking to the pot or the tools heated in it, cover the surface with a mixture of powdered charcoal, 1 quart; salt, 1/2 pint; yellow prussiate of potash, 1 gill; and cyanide of potassium, a lump the size of a walnut.

HARDENER.

To Prevent the Sticking of Hot Lead—2

To prevent lead from sticking to work that has many small corners or grooves, when heated in a lead bath preparatory to hardening, mix lampblack with water or alcohol to the consistency of paint and apply with a brush. Be sure that the mixture is thoroughly dried out before the piece is dipped into the lead bath. E. W. NORTON

To Prevent the Sticking of Hot Lead—3

One piece of a switch was required to be hard at one end and soft at the other. After trying several methods of annealing, a hot lead bath was used to anneal one end and leave the other end hard, but we then encountered the difficulty of the hot lead sticking to the work. To prevent this, proceed as follows: Mix common whiting or cold water paint with wood alcohol and paint the part that is to be annealed. The hot lead will not stick, no matter how long the piece is held in the spot. In doing the work mentioned, the pieces were lowered quickly into the hot lead and removed as soon as possible, in order to prevent drawing the temper of the hard end, and then the whole was plunged into a pail of cold water. Water will do as well as alcohol to mix the paint, but alcohol is the most convenient, inasmuch as it can be used without waiting for the paint to dry. If water is used, the paint must be thoroughly dry, as otherwise the moisture will cause the lead to fly.

E. J. LAWLESS.

Restoring Polish after Hardening

If a punch, reamer or other tool is to be hardened, and the color resulting from that process is undesirable, it may be removed by the following simple method. After the part is hardened, dip it into a glass filled with muriatic acid and allow it to remain for five seconds; then plunge it into a pail of water. In this way the polish of the steel will return and the temper will not be affected. This method is much quicker than obtaining a polish by the use of emery cloth.

JOHN C. MONRAD.

Cleaning Top of a Hardening Bath

Dust or small globules of oil, which sometimes give trouble by collecting at the top of hardening solutions, can be disposed of by placing a piece of ordinary newspaper on top of the solution; the dirt and oil adhere to the paper and are thus readily removed, thereby avoiding the labor of skimming the bath.

EMIL TSCHUDI.

To Heat Tips of Small Tools

Sometimes it is necessary to heat, for the purpose of hardening or annealing, the tips of small tools, such as countersinks, etc. To do this without heating other portions of the tool is at times difficult to accomplish. If the tool is inserted into a raw potato, exposing only the part to be heated, the operation is easily performed. J. V. N. CHENEY.

Bath for Hardening High-speed Steel

An excellent bath for hardening high-speed steel consists of a mixture of table salt and paraffin oil, in the proportion of one pound of table salt to each gallon of pure oil. The steel is heated to a lemon color, and plunged into the bath, being kept in motion until it has thoroughly cooled. The steel should come out of this bath gray in color, and nearly free from black spots. The bath referred to can be used for almost all brands of high-speed steel, with good results. H. S. STEEL.

Alloys for Drawing Colors on Steel

Alloys of various composition are successfully used for drawing colors on steel. To draw to a straw color use 2 parts of lead and 1 part of tin,

and melt in an iron ladle. Hold the steel piece to be drawn in the alloy as it melts and it will turn to straw color. This mixture melts at a temperature of about 437 degrees F. For darker yellow, use 9 parts of lead to 4 parts of tin, which melts at 458 degrees F. For purple, use 3 parts of lead to 1 part of tin, the melting temperature being 482 degrees F. For violet, use 9 parts of lead to 2 parts of tin, which melts at 594 degrees F. Lead without any alloy will draw steel to a dark blue. MAX DEHNE.

Paste for Hardening High-speed Steel

The hardening paste made according to the following receipt has been used on high-speed steel with success, enabling it to be hardened by heating in an ordinary gas oven, and thus making unnecessary the very high heat usually called for in hardening such steels. Mix 2 pounds rye meal; 1 pound common salt; 1/4 pound pulverized borax; 1/4 pound pulverized charcoal; 1/3 pint (or 1/2 pound) liquid cyanide of potassium; 1/2 gill or 2 ounces of water glass (silicate of soda); and 3 pints of water. The liquid cyanide is made by dissolving 3 ounces of pulverized potassium cyanide in one pint of boiling water. Mix thoroughly to form a paste.

When using this paste, apply it in the following manner: Provide a small cast-iron vessel or a crucible of the shape of a drip-pan, and spread a thin layer of the paste on the bottom; put the work in the pan and cover that with paste also. Place work and pan in the gas oven and heat until it reaches a nice full red. Dip in sperm, fish, or kerosene oil.

JOS. M. STABEL.

Heat-treating Small Steel Springs

Many mechanics find it difficult to temper small or delicate springs satisfactorily. Of course, it is not difficult to harden the steel, but to draw the temper evenly on a piece of steel 0.025 inch thick, for instance, requires some experience, especially if the spring is of considerable length in proportion to its width and thickness or is of a crooked or formed shape. However, the writer has found that the simple method described in the following will produce good results.

A small cup that has not soft soldered joints is filled about two-thirds full of sperm oil. The spring is laid on a piece of charcoal, heated evenly with a blowpipe, and dropped into the oil in the cup. The cup is then placed over a flame and heated until the oil flashes and takes fire. The oil is kept burning for about six minutes, after which the cup is removed from the flame, covered over with a piece of metal, and allowed to cool. An even or uniform temper will be obtained if the method described has been carefully followed. JAMES H. BEEBEE.

Formula for Casehardening

Yellow prussiate of potash, by weight, 7 parts; bichromate of potash, 1 part; common salt, 8 parts; pulverize the crystals and mix thoroughly. Heat the piece to be hardened to a dark red and dip into the preparation or sprinkle it on the piece. Return to the fire and let it soak, then repeat several times, according to the depth of hardened surface wanted. Finally plunge into water or oil. This may be used on tool steel, soft steel or iron.

JAMES P. HAYES.

Materials for Casehardening

The carburizing materials generally used are charred leather, powdered bone, cyanide of potassium, wood and animal charcoal, and prussiate of potash. Charred leather is used extensively, but there is a difference of opinion as to the best packing material.

Casehardening Mixtures

One part sal-ammoniac and 3 parts prussiate of potash; or, 1 part prussiate of potash, 2 parts bone dust and 2 parts sal-ammoniac.

E. H. McClintock.

Casehardening Cold Rolled Steel

To successfully caseharden common cold rolled steel so that it will answer for the cutters of inserted reamers, etc., pack the cutters in granulated raw bone in a cast-iron box with at least one-half inch layer of bone between the cutters and the sides of the box. Put on an iron cover and lute with fire clay; heat in a gas furnace to almost a white heat for from two to five hours, according to the size of the box. Then draw the box, open and dump quickly into a bath composed of the following: 1 quart of vitriol (sulphuric acid), 4 pecks common salt, 2 pounds saltpeter, 8 pounds alum, 1 pound prussiate potash, 1 pound cyanide potash and 40 gallons soft water.

F. Wackermann.

To Mottle Casehardened Pieces—1

There are several ways of obtaining the beautiful mottled effect on casehardened articles, but one of the simplest and most effective methods is as follows:

The usual cooling tank and screen for catching the work are used, but in addition an air pipe is run into the bottom of the tank in such a way that when the air is turned on the water is filled with air bubbles and is violently agitated. These air bubbles, striking the cyanide-coated articles during the cooling process, cause unusually attractive mottling.

E. V.

To Mottle Casehardened Pieces—2

A simple and effective way to get a mottled effect in casehardening with cyanide of potassium is as follows: Set an open pail or jar under a running hydrant, get the pieces good and hot (bright red) in a ladle of molten cyanide, then take out singly with tweezers and simply throw them into the water. The air bubbles rising through the water give the desired mottled effect. A still better process, if an air blast is at hand, is to connect a rubber hose in some manner to the bottom of the pail, so that a stream of air enters the water. This plan serves well where no special appliance is available for this class of work.

HARRY ASH.

To Caseharden for Colors

Mix 10 parts charred bone, 6 parts wood charcoal, 4 parts charred leather and 1 part of powdered cyanide potassium. Clean the work thoroughly, and do not handle with greasy hands. Pack the work with the mixture in a common gas pipe plugged at one end, and seal at the other with asbestos cement. Heat in a furnace to a dark cherry red and keep at that heat for about 4 or 5 hours. Dump in a tank

with compressed air bubbling up through the bottom. If the colors are too gaudy, leave out the cyanide. J. F. SALLOWS.

To Caseharden Locally—1

There are several methods of local hardening. One is to paint the work with enamel where it is to be hardened, and to copper-plate the parts that are to be left soft. When the work is heated, the enamel burns away and the surface then absorbs the carbon. The copper coating, however, has no affinity for the carbon. Experiments have shown that a layer of electrolytically deposited copper, from 0.001 to 0.002 inch thick, is suitable. If desired, the entire surface can be copper-plated and the plating ground off where the hardening is to be done. Another method is to cover the parts that are to remain soft with a bushing or with ordinary tire tape; still another is to use fire clay for the protective covering.

To Caseharden Locally—2

To caseharden part of a piece to a line or in a spot, cover the part or surface to be hardened with a moderately heavy coat of black japan enamel. Clean the work thoroughly, then put on a heavy coat of copper and the work is now ready to be carbonized, and is packed in a pot in bone or leather in the usual manner. Heat long enough to give the required depth of "case." Then take out of the fire and cool down in the pot. When cold, reheat and dip in oil or water. The copper blocks the absorption of carbon, while the japan burns off and allows the carbon in the bone or leather to be absorbed by the iron. E. W. NORTON.

To Caseharden Locally—3

The entire surface of the work, or that part which is to be hardened, should be coated with a moderately heavy coat of japan enamel, and then a medium heavy coat of copper should be applied to the remaining portion of the work. In applying the copper, care should be taken not to disturb the japan. After the copper is applied, the piece is ready to be carbonized. It should be packed, and heated to a bright red, and held at this heat long enough for the requirements of the work. Then the box or case containing the pieces to be casehardened is taken out of the fire and the work is permitted to cool in the box. When cool, the work is taken out and reheated in the open fire, and dipped in oil or water. The copper prevents the absorption of the carbon, while the japan enamel burns off and allows the carbon to take effect. E. S. WHEELER.

Annealing Steel—1

Steel parts may be annealed primarily to soften them sufficiently for machining or to remove internal strains resulting from rolling or hammering. Annealing is commonly done by packing the work in a cast-iron box containing some material such as powdered charcoal, charred leather, charred bone, sand, etc. After the box and its contents are heated to a temperature usually varying between 1400 and 1600 degrees F., they are allowed to cool slowly.

Annealing Steel—2

Cover the steel with fire clay, and heat to a red heat. Then allow the steel to cool overnight in a

furnace or forge. This method will prove satisfactory when other means fail. SAMUEL H. OWENS.

Annealing Steel—3

Smear the iron or steel with tallow, and heat slowly in a charcoal fire until it is a dark red. Allow it to cool itself. This method is all right for very hard tool steel. R. B. CASEY.

Annealing Steel—4

Heat slowly or rather evenly to a dull red heat. Put it in a dark place or corner, until all signs of red have just disappeared, then quench in water, taking care to hold it still. When annealing flat stock, heat evenly and thoroughly, place between two planed pine boards on an ash heap and cover with ashes. By this method the charcoal is produced, so to say, automatically. WM. B. BROOKS.

Annealing Steel—5

To anneal steel having hard and soft spots, remove the scale, and heat slowly and evenly to a little above a dark red. Immerse in fresh water until almost cool. Heat immediately to a dark red and anneal in the usual way. C. F. EMERSON.

Water Annealing of High-speed Steel

If it is desired to anneal only a few small pieces of steel rapidly, they can be "water annealed." In water annealing, the piece to be annealed is gradually and uniformly heated to 760 degrees F. It is then taken from the furnace and plunged into a bath of pure water, previously heated to a temperature

of 150 degrees F., where it is permitted to cool until reduced to the temperature of the bath. Afterwards the steel can be drilled, filed, or machined into any form with little difficulty. The more care devoted to the heating, the better the results will be. To heat rapidly will induce internal strains and greatly increase the risk of breakage when the pieces are plunged into the water bath.

To Anneal Zinc

In working zinc, the greatest loss is on account of the zinc cracking and being too brittle to handle to advantage.

To anneal, heat in oil to about 500 degrees F. and plunge in hot soda water, which works the double operation of drawing the zinc to the proper degree and at the same time cleanses the surface from the oil. HARDENER.

To Anneal Finished Copper

To make a mixture for protecting finished copper pieces which require annealing, mix to a thick consistency white cold water paint and alcohol and apply to the copper with a brush. Allow the mixture to dry and then heat to a low red by dipping into pure melted lead at the required temperature. Cool in air or water, preferably the latter. L. C. CARR.

HEAT-TREATMENT OF CAST IRON

Iron castings that are too hard to machine or which have hard spots destructive to tools may be annealed by packing closely in covered cast-iron boxes with black manganese, and heating to a temperature of 1500 or 1600 degrees F., until thoroughly heated through. A large box packed in this manner with a closely fitted cover luted with fire clay must be heated for several hours to raise the interior to the annealing temperature.

To be sure of getting the interior heated properly, a number of wires should be placed in the box, projecting through the cover, where they can be conveniently grasped with tongs and pulled out one at a time to show how far the heat has progressed. When the interior has reached a bright red heat the box should be hauled out and covered with ashes so that it will cool slowly. It is claimed that hard spots in gray iron castings can be softened with black manganese by applying the manganese and heating to a dull red, using a blow-torch or any other convenient means of heating. M. E. CANEK.

To Harden Cast Iron—1

To toughen and surface-harden small cast-iron machine parts which are subjected to wear, such as small gears, cams, etc., heat to a dull red and quench in a saturated solution of cyanide of potash and water, which should be kept as near boiling point as possible. This can be accomplished best by putting the solution in an iron pot near the fire in which the parts are being heated. J. H. V.

To Harden Cast Iron—2

The following process can be used for hardening cast iron whether rough or after machining. The casting is first heated to a cherry-red heat; it is then dipped in a bath which consists of a practically anhydrous acid of high heat-conducting power, preferably sulphuric acid of a specific gravity of from 1.8 to 1.9, to which is added a suitable quantity of one or more of the heavy metals or their compounds—such, for example, as arsenic. The preferable ingredients of the bath are sulphuric acid of a specific gravity of approximately 1.84 and red arsenic in the proportions of 3/4 pound of red arsenic crystals to 1 gallon of sulphuric acid. The castings may either be dipped suddenly in the solution and then taken out and cooled in water, or they may be left in the bath until cool. In preparing the bath, when sulphuric acid and red arsenic are used, better results are obtained when the crystals are added to the sulphuric acid and the bath is allowed to stand for about a week before using.

O. G.

To Harden Cast Iron—3

To harden cast iron, take 1/2 pint vitriol (sulphuric acid), 1 peck common salt, 1/2 pound saltpeter, 2 pounds alum, 1/4 pound prussiate potash, and 1/4 pound cyanide potash; dissolve in 10 gallons of water. Heat iron to a cherry red, dip, repeating until hard enough.

Caution: When cyanide of potash and sulphuric acid combine, hydrocyanic-acid gas is generated, which is a deadly poison to inhale. Great care should, therefore, be taken not to add the sulphuric acid to

the cyanide of potash until the latter has been placed in the ten gallons of water called for by the receipt, so as to dilute the solution and render the generation of the gas less rapid. Under no circumstances should this rule be deviated from.

Chilling Cast Iron

Mix together 1/2 pint of oil of vitriol, 2 ounces of saltpeter, and 3 gallons of clean water. Heat the casting, and plunge it in this solution, keeping it there until cold. GEORGE E. HETZLER.

To Soften Cast Iron for Drilling

Heat to a cherry red, allowing it to lie level in the fire. Then with a pair of cold tongs put on a piece of sulphur a little less than the size hole to be drilled. This will soften the iron entirely through, providing it is not too thick. O. E. VORIS.

To Caseharden Cast Iron—1

To successfully caseharden cast iron, the pieces to be hardened should be heated to a red heat, then rolled in a composition of equal parts of prussiate of potash, sal-ammoniac and saltpeter—all pulverized and thoroughly mixed. Every part of the casting must be covered by the composition before plunging (red hot) into a bath of 2 ounces prussiate of potash and 4 ounces sal-ammoniac to each gallon of cold water. A.

To Caseharden Cast Iron—2

To caseharden cast iron, use a pot of suitable size for the piece, packing it in with 2/3 raw bone and

1/3 charcoal ground to about the same size as the bone. Seal the pot cover with fire clay and place in a furnace and run it about 5 hours. Then take out the work and dip in oil or water. E. W. NORTON.

To Caseharden Cast Iron—3

To caseharden cast iron, use the following receipt: Pulverize and mix together equal weights of saltpeter, prussiate of potash and sal-ammoniac. Make a dipping solution by adding to each quart of cold water 1 ounce prussiate of potash and 1/2 ounce sal-ammoniac. Heat the cast-iron pieces till red hot, roll them in the powder, and then plunge them into the liquid. J. M. MENEGUS.

To Caseharden Cast Iron—4

Place casting in such a position that the part subject to wear is immersed in a cyanide bath. After being heated in this bath for twenty minutes, the part should be quenched quickly in cold water. This treatment produces a hardened case nearly 1/32 inch deep on cast-iron arms, the ends of which are subjected to considerable wear. J. E. FENNO.

LUBRICANTS FOR BEARINGS

It is important that lubricating oils be free from acids, that they have the proper body, and that they be free from gum. The following method of testing lubricating oil should be of interest to purchasing agents and engineers of manufacturing plants where the services of a chemist are not available. To test for acids, pour some of the oil in a glass, together with a small quantity of litmus solution, and heat the glass in warm water. If the solution turns red, it indicates that there is acid in the oil. If it remains blue, the oil contains practically no acid.

In order to examine the oil for "body," take a long piece of glass and place it in a slanting position. Pour some drops of the oil to be tested on the highest point of the glass. It is obvious that the oil which runs the farthest is that which contains the least body. To test for gum, allow the oil in the second test to stand for a few hours. Then proceed to rub the oil off. Should the oil feel sticky, it indicates that it is mixed with plant or gum oil, which is detrimental to the machinery.

LAWRENCE E. OLSEN.

Lubricating Oil for Heavy Duty

An excellent lubricating oil for heavy-duty and fast-running journals may be made by mixing equal parts of sperm oil, cylinder oil and "black strap" or common machine oil. A. D. KNAUEL.

Fine Oil for Delicate Machinery

Put small zinc and lead shavings in equal quantities into best olive oil, and place the oil in a cool place until it becomes colorless. O. G.

Lubricant for Low Temperatures

Because of the congealing or thickening of the greases customarily used, the oiling of machinery, particularly that used in unwarmed places, is in winter sometimes difficult. Oils thinned with kerosene do not readily thicken or congeal. A combination of cylinder oil, kerosene, and graphite will stand a temperature several degrees below zero without losing its capacity for flowing freely. The cylinder oil and graphite should be mixed to the consistency of a thin paste, and this thinned by the addition of kerosene until it flows quite freely. B.

Lubricant for High-speed Bearings

To prevent heating and sticking of bearings on heavy machine tools, due to running continuously at high speeds, fill an oil can with a good spring bottom about one-eighth full of Dixon's flake graphite, and the remainder with kerosene oil. As soon as the bearing shows the slightest indication of heating or sticking, this mixture should be forcibly squirted through the oil-hole until it flows out between the shaft and bearing, when a small quantity of thin machine oil may be applied. H. J. Bachmann.

Self-lubricating Bearings

In hard gun-metal bushes, bore a good fit to shaft and split, drill four holes per square inch of surface, each 1/4 inch diameter by 1/4 inch deep. The holes are to be flat at the bottom and to be spaced zigzag, so that one row of holes is between the holes in the opposite side. Fill the holes with a compound prepared as follows: Melt 1 pound solid paraffin and

add 2 ounces of litharge, dissolved insinglass and sulphur; add further 2 pounds of fine plumbago and mix thoroughly.
J. H. HOLDSWORTH.

Graphite as a Lubricant

Graphite, which is also known as black lead and plumbago, is frequently used as a lubricant for bearings, engine cylinders, etc. When mixed with grease, thus forming a paste, graphite is adapted to the lubrication of slow-running journals, especially when the bearing pressures are high. Graphite is also mixed with oils and, in some instances, it is used unmixed with other materials. Natural graphite serves an excellent purpose in cast-iron bearings, where it appears to smooth the surface of the porous metal.

Lubricant for Large Planers

When very heavy work is to be done on a planer it may happen that the oil or other lubricant used on the ways of the planer does not possess sufficient "body" to resist the pressure, and the wearing surface will be cut or badly "roughed up." In one case, the planer table weighed eleven tons and the load to be put upon it thirteen tons, making twenty-four tons in all. The bearing surfaces of the V's appeared very narrow to successfully support such a weight. To avoid cutting, the surfaces were lubricated with a mixture of one gallon of "Vacuum" cylinder oil and one pound of Dixon's flake graphite. The planing job was easily and successfully done with no injury to the wearing surfaces.

OSCAR E. PERRIGO.

Cooling Compound

A cooling compound for the necks of rolls and shafts is made as follows: Dissolve 2 1/4 pounds of lead acetate in 14 pounds hot tallow and add 2 1/4 pounds black antimony. Stir the ingredients constantly until cold.

W. R. Bowers.

Oil for Micrometer Screws

To prepare oil for micrometers, fine mechanisms, etc., take neatsfoot oil and put into it some lead shavings in order to neutralize the acid contained in the oil; let this stand for a considerable time, the longer the better. Oil thus prepared never corrodes or thickens.

Joseph M. Stabel.

Grease for Gear Wheels

A good grease for gear wheels where iron meshes into iron can be made of 1 part of graphite, and 4 parts of tallow mixed with some oil.

Max J. Oches.

Lubricant for Worm Gearing—1

Worms and worm-wheels under heavy duty often wear out quickly when run dry, or when lubricated with common machine oil. Cases have been known where worm-wheels gave out in three weeks' time when lubricated with ordinary oil, and, when supplied with a special lubricant, ran continually with no perceptible wear. The following is a compound which has been used with satisfactory results for this purpose: To one gallon of prime lard oil, add 1 1/2 gallons of steam cylinder oil, one 1-pound package of Dixon's graphite, and 2 quarts of flowers of

sulphur. Mix this compound thoroughly and keep the worm almost entirely submerged all the time.

Lubricant for Worm Gearing—2

Another compound which is recommended for worm gearing is composed of the following ingredients: Cylinder oil, 2 gallons; common flour, 1 pound; common salt, 1/2 pound. It will be found that the flour will make the oil heavy enough to stick, while the salt will so glaze the worm and gear that they will run smoothly without any tendency to "score." In extreme cases, where the worm-gear runs hot, owing to continuous and fast running and to friction, it is sometimes advisable to add to the above 1/2 pound of graphite. The lubricating and cooling properties of graphite are well known.

Lubricant for Lathe Centers—1

An excellent lubricant for lathe centers is made by using 1 part graphite and 4 parts tallow thoroughly mixed. E. C. Noble.

Lubricant for Lathe Centers—2

The following lubricants are recommended for lathe centers: 1. Dry or powdered red lead mixed with a good grade of mineral oil to the consistency of cream. 2. White lead mixed with sperm oil with enough graphite added to give the mixture a dark lead color (when necessary, thin by adding more oil). 3. Graphite, one part, and tallow, four parts, the two ingredients being thoroughly mixed.

PICKLING BATHS

Chemical treatment is used to attack surface impurities and to remove grease from objects immediately before plating. In order to remove the grease from a surface that is covered with grease and oxide, the object is dipped in a boiling solution composed of from 5 to 10 per cent of caustic potash, or some cleaning compound made for this purpose; benzine or naphtha is often used. After washing off the potash solution that adheres on removal from this bath, the object is immersed in a pickling bath, which varies in composition, according to the metal to be cleaned.

Iron Pickling Bath

Iron may be pickled in 10 per cent of sulphuric, hydrochloric, or nitric acid, any one of which leaves the surface black. A bright surface may be obtained by a pickle made of 10 quarts of water; 28 ounces of concentrated sulphuric acid; 2 ounces of zinc (which dissolves); and 12 ounces of nitric acid. After mechanical cleaning and polishing, grease is again removed by immersion in boiling potash, and, after washing in water, the object is pickled in dilute sulphuric acid or is scoured with pumice powder. It is then washed and immersed in the plating bath. Hydrofluoric acid may be used for cleaning iron castings and removing light scale and rust from iron. A solution made by mixing one gallon of acid to 20 or 25 of water will clean ordinary castings in an hour or less. This acid should be handled with great care, for, when concentrated, it causes painful burns.

Zinc Pickling Bath

Zinc is attacked by caustic alkali, so that it must not be left long in this bath. After washing off the alkali, the zinc is pickled either in 10 per cent sulphuric acid or in a mixture of equal parts of concentrated nitric and sulphuric acids, to which one-half per cent of sodium chloride has been added. If the zinc is not badly oxidized, simply polishing with wet pumice powder and a hand brush and subsequent washing in water is a suitable preparation for plating.

Copper and Brass Pickling Bath

Copper and its alloys, such as brass, bronze, and German silver, are cleaned and brightened in a pickle of the following composition: 50 parts, by weight, of concentrated sulphuric acid; 100 parts, by weight, of 53 per cent nitric acid (36 degrees Baumé); 1 part of salt; and 1 part of lampblack.

If there is to be no further mechanical treatment and the objects are to be placed immediately in the electroplating bath, the pickling is carried out in two stages; (1) in a preliminary pickle and (2) in a bright dipping bath. The preliminary pickle is made as follows: 200 parts of 53 per cent nitric acid (36 degrees Baumé); 1 part of salt; and 2 parts of lampblack. The articles should remain in this pickle until all impurities are removed, and then be immersed in a bright dipping bath of the following composition: 75 parts of 62 per cent nitric acid (40 degrees Baumé); 100 parts of concentrated sulphuric acid; and 1 part of salt.

After mechanical treatment and polishing, the grease must be removed by a boiling potash solution; this is followed by pickling in a 10 per cent potas-

sium-cyanide solution, washing, and, as a final precaution, by scouring with pumice powder, and washing.

Lead Pickling Bath

Lead and britannia metal (90 per cent of tin and 10 per cent of antimony) are dipped in caustic potash and scoured with lime or pumice. Dilute nitric acid may also be used as a pickle for these metals.

Aluminum Pickling Bath

Aluminum is especially difficult to prepare for plating because of the rapidity with which the surface oxidizes. Burgess and Hambuechen recommend cleaning with dilute hydrofluoric acid, thus slightly roughening the surface; then dip in a mixture of 100 parts of concentrated sulphuric acid and 75 parts of concentrated nitric acid; wash in water, and plate with zinc, from a solution of zinc and aluminum sulphates slightly acidified with sulphuric acid and containing 1 per cent of hydrofluoric acid, or an equivalent amount of potassium fluoride. The solution has a density of 15 degrees Baumé.

After plating for 15 minutes with from 10 to 20 amperes per square foot, the article may be removed, washed, and plated with silver or copper. If gold is to be deposited, the zinc must be covered with copper, as gold will alloy with zinc in the course of time and disappear.

Electrolytic Cleaning

Cleaning may be carried out electrolytically by hanging the object in a hot bath composed of 10 per cent caustic alkali and connecting to the negative

pole of the machine the same as in plating. An iron anode is used; the hydrogen deposited on the surface reduces the oxide. If made of iron, the tank may be used as the anode.

Pickling Castings to Remove Scale

The pickling of castings consists in immersing them in an acid bath in order to soften and remove the sand and scale on the surface of the castings, so as to make it easier to machine the castings and reduce the wear of tools and the time required for their resharpening and resetting. The pickling solutions used for removing scale from castings and forgings preparatory to milling or other machining operations are usually composed either of dilute sulphuric acid, oil of vitriol, or hydrofluoric acid.

Solution for Iron Castings

Iron castings are usually pickled with sulphuric acid. The sulphuric-acid pickling solution is generally made up of 1 part of sulphuric acid to from 4 to 10 parts of pater. *The sulphuric acid should always be poured into the water while the latter is being stirred.* The reason for this is that a chemical reaction takes place which causes the bath to become quite warm, but there is no dangerous ebullition if properly mixed; but if the water is poured upon the sulphuric acid, the latter, being much heavier than water, remains at the bottom.

When an attempt is made to stir the solution, the water enters the acid in small streams, and is instantly raised to the boiling point, generating steam, which may cause an explosion and throw the acid, thus resulting in serious burns.

Concentrated sulphuric acid is frequently kept in iron tanks, but dilute sulphuric acid attacks iron readily, and, hence, it is necessary to keep dilute sulphuric acid in earthenware jugs and jars, glass bottles, wooden tubs, or vats.

When the scale is loose, the castings should be removed and washed, preferably with hot water. If the castings are small, it is a good practice, after washing, to immerse them in a soda solution for a short time in order to thoroughly neutralize any remaining acid.

Objection to Use of Sulphuric Acid

One great objection to the use of sulphuric acid as a pickling solution is that if there are any soft or spongy spots in the iron the acid will penetrate these, and it would be practically impossible to wash it out or neutralize it in the soda bath. Any acid thus entrapped in the castings will continue to eat until it is changed to sulphate of iron or green vitriol. This will tend to make the spongy or soft spots in the iron still worse, and may weaken the castings to a large extent. If the acid has been used a number of times, a large portion of it is converted into green vitriol, and, hence, the solution will not attack the iron. In this case, it is necessary to add more acid to the bath or else to throw away the old bath and make up a new one.

Pickling with Hydrofluoric Acid

Hydrofluoric acid, if used with care, makes a pickling solution which has a number of advantages over sulphuric acid. Hydrofluoric acid is commonly sold

in three grades. The first contains 30 per cent of acid, the second, 48 per cent, and the third, 52 per cent, the balance of the solution being water. The 30 per cent solution is that usually employed for pickling castings. One gallon of the 30 per cent solution should be used with from 20 to 25 gallons of water. If it is desired to pickle more rapidly, less water may be used, and if it is desired to derive more use from the acid—that is, make it do more work—slightly more water may be used. Hydrofluoric acid does not act upon the iron to an appreciable extent, but attacks the sand and dissolves it. It also dissolves the black oxide of iron.

Receptacles for Hydrofluoric Acid

Owing to the fact that hydrofluoric acid will attack sand, it cannot be kept in a crock or jug, as it would quickly eat a hole through the jug and escape. Hydrofluoric acid must be kept in a lead carboy, but the dilute acid can be kept in wooden tubs or barrels. Either dilute or concentrated hydrofluoric acid will dissolve glass very readily, and, hence, cannot be kept in a glass bottle.

Application of Hydrofluoric Acid

When pickling with hydrofluoric acid, the small castings may be put into the bath and the larger ones may have the acid poured over them, the same as if working with sulphuric acid. The hydrofluoric acid bath is always used cold, but should be kept above the freezing point. The bath can be used repeatedly by adding about one-third the original quantity of acid before introducing a new lot of castings.

Surfaces of Pickled Castings

When castings are pickled in sulphuric acid, the surface is left with a dull or black appearance. When pickled in hydrofluoric acid, the surface has a much whiter and often an almost silvery appearance. The surfaces of castings pickled with hydrofluoric acid are also very much smoother than those pickled with sulphuric acid. For this reason, hydrofluoric-acid pickling is used in almost all cases in which the parts are to be polished or nickel-plated, and sulphuric-acid pickling only in cases where it is desired to remove the scale in order to facilitate the machining of the castings.

If it is desired to keep the surfaces of the castings bright after they are pickled in hydrofluoric acid, they should be washed with hot water immediately after coming out of the acid, and should be left in the water until they are heated through. If this is done when the castings are taken out of the water, they will dry quickly from the heat which they have absorbed from the water. If the castings are washed in cold water, they will remain wet for some time and, hence, will rust. A little lime is frequently added to the washing water which is used after hydrofluoric-acid pickling.

Injuries from Hydrofluoric Acid

While the workmen may receive quite serious burns from sulphuric acid, it is not nearly so dangerous as hydrofluoric acid. The thin hydrofluoric acid will penetrate the skin and attack the flesh and bones underneath and may result in very serious injuries. It will also attack the finger nails very readily. When handling concentrated hydrofluoric acid, the work-

man should always use rubber gloves. If any acid is dropped or splashed on the skin, it should be washed off at once with water and dilute ammonia; this will usually prevent any injury. The dilute hydrofluoric acid of the pickle bath will not attack the skin instantly, but the workman should never put his hands into this solution, as it will attack the hands to some extent and will result in serious sores if he persists in handling the castings when wet with the pickling solution. The dilute sulphuric-acid pickling solution will not injure the hands if it is spilled upon them; in fact, its only effect is to make the skin coarse and rough.

Pickling with Oil of Vitriol

When oil of vitriol is used, the pickle should be made of 1 part of vitriol to 4 parts of water. It is a common mistake to think that more vitriol will hurry the operation and do the work more thoroughly; an excess of vitriol retards the action and, therefore, should be avoided. In preparing the pickle, the water is put in first and the vitriol is added gradually, during which process the water heats up. Fill the tank to within six inches of the top.

The articles to be pickled, if of convenient size to handle, are simply dipped in the pickle, so that they are wet all over, and then laid on the platform to drain and dry. If the castings are too large or too heavy for dipping, they are laid on the platform and the pickle is then poured over them with a dipper. They should be turned as much as is necessary to wet them all over, and none of the castings should be left so that the pickle has a chance to settle in pockets or places that will not drain. The castings

are then left for 8 or 12 hours, when they will be covered with a white powdery substance. It is only necessary to dip the castings in boiling hot water, or to pour the hot water over them until they are thoroughly cleansed of the acid, and, when they are dry, the process is completed. A hot water tank should be provided with a steam pipe for heating the water. This water should be renewed frequently, so that the acid will be thoroughly removed. An additional refinement is to provide a hot potash or soda bath before the final rinsing in clean water.

Pickling Tank for Oil of Vitriol

The tank used in connection with the "quick process" just described should be a lead-lined wooden tank of a size and shape determined by the size, shape, and quantity of castings to be handled. With a tank 6 feet long, 3 feet wide, and 2 feet deep, a large quantity of castings can be pickled. This tank should preferably be sunk a foot into the ground, and from one of the long sides a wooden platform, say 6 feet wide and 12 feet long, with raised strips on the edges, should extend back. The platform should have a pitch of two or three inches to the foot toward the tank.

The Slow Oil of Vitriol Process

To pickle by the "slow" process, tanks are provided of sufficient capacity to submerge the castings for several hours; sometimes they may remain in the pickle overnight. When taken out, the castings should be rinsed at once in an adjoining tank containing clear water, or still better, in two tanks in succession. The pickle for the "slow" process should

be much weaker than for the first process described, the proportion of vitriol to water being about as 1 to 10.

Acid Pickling for Forgings

To remove scale from drop forgings which have to be machined, dip in a pickle composed of hot water, 24 parts; sulphuric acid, 1 part. In adding sulphuric acid to water, the acid should always be poured into the water while the latter is being stirred.

To Pickle Brass Castings

An excellent mixture to use for cleaning and brightening brass castings is as follows: Two parts, by measure, of nitric acid, and three parts of sulphuric acid. To each quart of the acid mixture made up, add one pint of common salt and stir until dissolved. The solution may be held in any suitable receptacle, say, of glazed earthenware. It is only necessary to provide a vessel large enough for the immersion of the largest piece to be dipped. The pieces are simply dipped and removed at once, and then rinsed in clear water. This solution is intended only for cleaning and brightening the castings, and not for imparting any color. T. E. O'DONNELL.

Acid Dip for Bronze Castings

An effective acid dip for bronze castings may be made in the following manner: Use one gallon pale aqua fortis, 1 gallon oil vitriol, 4 quarts of water, and 8 ounces of rock salt. In mixing the acids, add the vitriol to the aqua fortis, after which the water should be introduced, by pouring it very slowly into the acid solution. Water should never be poured into

the acids separately. When the water and acids have become thoroughly mixed, the salt may then be added. The solution becomes quite warm after mixing, which is a good time to add the salt, as the heated solution dissolves the salt readily.

After mixing, the solution should stand from 10 to 12 hours before using. It is preferable to make a large quantity of the solution if much dipping is to be done. To secure the best results it is necessary that the solution be kept at as low a temperature as possible; hence, it is advisable to place the receptacle in a tank of cold water, or in running water.

T. E. O'DONNELL.

Recovering Copper from Dipping Acids

Some copper is dissolved when dipping brass castings in acid to clean them. In order to recover this copper, run the acid liquids from the washing tanks into a large wooden vat containing milk of lime, and stir thoroughly. The lime neutralizes the acids and precipitates the sulphuric acid as sulphate of calcium. This acid is neutralized first, then the nitric acid is acted upon, and nitrate of calcium is produced. The clear liquid contains nitrate of calcium and nitrate of copper. Run this solution through any kind of scrap iron. The iron removes the copper from the solution, dissolving and taking the place of the copper. The copper settles at the bottom of the tank as a slush. At intervals, the copper may be taken out of the vat, dried, and melted into ingots. All of the copper may be recovered if the supply of scrap iron is kept up.

POLISHING COMPOUNDS

A good metal polish for gold, silver, brass, nickel, etc., can be made by taking powdered crocus and mixing enough kerosene oil with it to make a paste. This paste must be rubbed very thoroughly over the article to be polished. Then take a flannel cloth and rub lightly and rapidly until a brilliant polish is obtained.

HERBERT C. SNOW.

Compound for Cleaning Brass

To make a brass cleaning compound, use oxalic acid, 1 ounce; rotten stone, 6 ounces; enough whale oil and spirits of turpentine of equal parts to mix and make a paste.

G. E. HETZLER.

Brass Polishing Solution—1

A good polishing solution for brass is made by putting 2 ounces of sulphate of nickel and 2 ounces of nitric acid in an open vessel and allowing them to mix thoroughly. Then add water.

Brass Polishing Solution—2

An excellent liquid polish for articles of brass may be made as follows: Add together and mix thoroughly, 100 parts of powdered pumice stone, 2 parts oil of turpentine, 12 parts soft soap and 12 parts of fat, oil or lard. When thoroughly mixed, add the mixture to a solution of 3 parts oxalic acid dissolved in 40 parts of hot water. Stir until a uniform paste is formed. Apply with cloth, rub well, remove, and polish with dry cloth.

T. E. O'DONNELL.

Brass Polishing Solution—3

To 2 quarts of rain water add 3 ounces of powdered rotten stone, 2 ounces of pumice stone and 4 ounces oxalic acid. Mix thoroughly together and let it stand a day or two before using. Shake it before using, and after application polish the brass with a dry woolen cloth or chamois skin.

DONALD A. HAMPSON.

For Buffing Nickel

For buffing nickel work, there is nothing that will give a luster equal to Vienna lime composition. It can be made by the user, but it is more satisfactory to buy it of the manufacturer, as when homemade it air-slacks very rapidly; it is put up by the makers in air-tight cans of about one pound each, and this shape will keep until used up. It is also a good buffing composition on brass or other metals where there is not much cutting down to do, as it will cut down and color in one operation. If there is much cutting down, go over the work first with tripoli, then color with rouge or lime. All these compositions are put up in different grades for fast cutting, and also for dry or greasy work. J. L. LUCAS.

To Polish Nickel Plate

Apply rouge with a little fresh lard or lard oil with a piece of buckskin. Rub the bright parts, using as little of the rouge and oil as possible. Wipe off with a clean cloth slightly oiled. Wipe every day and polish as often as necessary. This is also an excellent preventive of rust.

DONALD A. HAMPSON.

Solution for Steel

To make a polish for steel, dissolve 2 ounces each of oxalic acid, pumice stone, ammonia, and whiting in a quart of water. HERMAN JONSON.

Liquid Metal Polish

A good liquid metal polish for cold smooth surfaces, either iron or brass, may be made from the following ingredients: To 3 parts of benzine add 2 ounces of oxalic acid and 1 1/2 pounds of silicate acid powder. This polish may be made in large quantities and set aside for further use provided it is kept in tightly closed bottles, and shaken well before using. Apply the solution with a piece of cloth. When dry, polish with a soft, clean cloth.

T. E. O'DONNELL.

Paste Metal Polish

A paste metal polish that is good for any smooth surface, whether hot or cold, can be obtained from the following ingredients, which will make about 20 pounds of the polish: 2 ounces of spermaceti, 4 ounces of cake tallow, 10 star candles, 2 1/2 pints of raw linseed oil, 2 1/2 pints kerosene and 5 pounds of tripoli powder. Procure a crock that will hold 3 or 4 gallons. Put in the tallow, spermaceti and candles, and melt over a slow fire. Then add the linseed oil and kerosene, and stir well. While this mixture is still warm, remove from the fire, and add the tripoli powder very slowly while constantly stirring the mixture. When all the powder has been added, allow to cool. To use, apply with a soft cloth, and after drying, remove the remnant and rub the surface with a piece of soft flannel. T. E. O'DONNELL.

Polishing Powder

Get two or three oyster or clam shells and burn them on a clear coal fire for fifteen or twenty minutes; then powder them in a mortar. This makes a superior metal polish. It is the best thing I have ever used for polishing silver and gold articles, and if finely pulverized can be used on the most delicate article without injury. REX McKEE.

To Remove Tempering Color

To remove the bluing from tempered steel, plunge the blue-hot article into a bath of sulphuric acid, 1 part; water, 16 parts; then into a bath of lime and water (to neutralize the acid) and rub it off quickly with a dry cloth and Vienna lime. The result will be a most beautiful polish. F. H. JACKSON.

Cleaning Polished Parts

Stains of every description on the polished parts of machinery, such as may result from dried oil, etc., may be easily and effectively removed by the application of alcohol. CALVIN B. ROSS.

To Prepare Fine Abrasive Quickly

To quickly prepare fine abrasive, use FFF emery or "15-minute" carborundum with benzine or naphtha for a liquid, mixing them in a square bottle. Use about two ounces of the abrasive to one quart of liquid; shake well and then lay the bottle flat on its side for the number of minutes needed to settle; then pull the cork and let the liquid flow out until level with the cork hole bottom. The liquid just drawn off can be used at once with a brush, but by

allowing it to stand for a time, the top portion can be poured off, leaving the abrasive with a little benzine, which will evaporate quickly and leave the clear powder. The term "15-minute" carborundum is applied to fine abrasive obtained by the process just explained (manufacturers, of course, using tanks instead of bottles), the time the liquid is allowed to stand, in minutes, being used to distinguish it. Thus, if it stands 15 minutes it will be known as 15-minute abrasive, etc.

To Prepare Tripoli or Emery Cake

Tripoli, emery cake and crocus are all made in practically the same manner, the change being made in the composition when it is desired to have the composition more greasy. Melt tallow and paraffin wax or beeswax together. Beeswax is by far the best, but the cost of the same has led to the use of paraffin, which in many cases will work equally as well. After the tallow and wax are thoroughly melted, add tripoli or emery, whichever is to be made, a little at a time, and stir in well until it is as thick as is possible to make it; then pour out into a large tin, or better still, into the molds made for the purpose, and allow to cool. J. L. LUCAS.

Glue Used in Polishing

Hide-stock glue is most generally used in the polishing industry. It is made from the skins of cattle, rabbits, and other animals. Glues are often blended; for example, a sheep-stock and goat-stock glue makes an exceptionally strong holding medium, and, when mixed with ox fleshings, forms a glue which

has more strength than a glue made entirely from rabbit or some other similar stock. The cheaper grades of glue are usually mixtures of bone and hide glues.

The color of glue, which is usually dark and hazy, may be lightened by the use of oxide of zinc, chalk, or talc, and these will produce a white or opaque fluid. Sometimes the use of these and similar substances in glue is an advantage in the polishing room, if the moisture or humidity is high, as when the factory is near a body of water. Under these conditions, glue containing the substances mentioned will set easier and retain its strength longer. The use of such combinations for polishing wheels, however, should be undertaken only under the direction of those understanding the conditions.

Fish glues are not suitable for use in metal polishing, in spite of the fact that the most powerful adhesive known (isinglass) is a fish glue. Isinglass is marketed in various solid forms, and is sometimes mixed with hide-stock glue to make belting cement and to bond bullneck polishing wheels in which disks of this kind of leather are glued together to construct a wheel. It is not used, however, to hold the abrasive to the face of polishing wheels.

Polishing Wood—1

A very nice polish on wood is obtained by using the following mixture: 1/2 pint of alcohol, 1/4 ounce of shellac, and 1/4 ounce of rosin. Dissolve the shellac and rosin in the alcohol; then add 1/2 pint of linseed oil, and shake the whole mixture. Apply with a sponge, brush or flannel. Rub the wood thoroughly after the application. E. W. NORTON.

Polishing Wood—2

The wooden parts of tools, the forearms and stocks of guns, etc., are often made to have a fine appearance by French polishing, but this finish adds little or nothing to their durability. To obtain a much better finish, soak the wood in linseed oil for a week and then rub it with an oil-soaked cloth a few minutes every day for a week or two longer. This solidifies and preserves the work. A. L. MONRAD.

Ebonizing Wood Handles

To prepare a mixture for ebonizing wood handles, etc., use logwood, 2 pounds; tannic acid, 1 pound; and sulphate of iron, 1 pound. Apply hot and polish when the pieces have become dry and cold.

W. R. BOWERS.

RUST PREVENTION

When the atmosphere, sea water, acids, or similar substances with which iron or steel comes into contact, attack the iron by forming oxides or rust upon its surface, corrosion is said to take place. Iron and steel cannot stand exposure to the atmosphere, particularly when excessive moisture is contained in the air, for any length of time, without the protection of some covering or coating which excludes the moisture and which, in itself, is not attacked by the influence of the atmosphere.

Rust Preventive—1

Melt 4 ounces of rosin in 1 quart of linseed oil and mix with 2 gallons of kerosene oil. The mixture is readily applied with a cloth or brush, and can be easily removed. M. E. Canek.

Rust Preventive—2

To preserve steel from rust, dissolve 1 part caoutchouc and 16 parts turpentine with a gentle heat, then add 8 parts boiled oil, and mix by bringing them to the heat of boiling water. Apply to the steel with a brush, the same as varnish. It can be removed again with a cloth soaked in turpentine.

A. L. Monrad.

Rust Preventive—3

To make a mixture that will prevent hardware and machinists' tools from rusting, take one-half pint of Demar white varnish, and mix it well with one gallon of turpentine. When the polished surfaces are

thoroughly covered with a thin coat, the varnish will scarcely show, but will preserve the polish for years, if it is not scraped off with something very hard.

H. E. Wood.

Rust Preventive—4

The following receipt has been used for a number of years, and is O. K. in every respect. Take a pound of vaseline and melt with it 2 ounces of blue ointment—what druggists call one-third—and add, to give it a pleasant odor, a few drops of oil of wintergreen, cinnamon, or sassafras. When thoroughly mixed, pour into a tin can. Keep a rag saturated with the preventive to wipe tools that are liable to rust.

F. H. Jackson.

Rust Preventive—5

To make a preservative oil, use high test grain alcohol and best grade of sperm oil, equal parts. Keep in a tightly-corked bottle, and shake well before using, as the alcohol and oil separate after standing. Any moisture on a tool or gun at the time of application is quickly absorbed by the alcohol, which in a short time evaporates, leaving a good coat of sperm oil to protect the surface from rust.

E. W. Norton.

Rust Preventive—6

Rust formation takes place on tools within a few hours after they have been hardened in brine or in any of the numerous hardening solutions containing different salts used for this purpose. To counteract this rusting of tools, they should be boiled in a strong

solution of soda water for fifteen or twenty minutes after having been hardened. Sal soda (common washing soda) is the kind to use for the solution. A kettle holding about six or eight gallons of water may be used. About five pounds of soda are put in at the start, and after that about one to one and one-half pounds is added every day. In this way the strength of the solution is kept about right.

The addition of soda is necessary on account of the overflow which is required because of the method used for heating, the solution being brought to the boiling point by introducing steam. The work should always be boiled before being put into the tempering furnace and the latter should be at a temperature of about 212 degrees F., when the tools are changed from the soda kettle to the furnace. A basket arrangement with windlass may be used for raising and lowering the work, to prevent scalding the hands. The directions given, if followed, will prove of advantage in hardening and tempering tools, in that the formation of rust will be prevented.

George Coles.

To Prevent Screws from Rusting

To prevent screws from getting rusty and sticking tight, instead of using ordinary oil only, add some graphite. After years you will be able to unscrew them with ease, and find them as bright as new, even if they have been exposed to very damp air.

J. M. Menegus.

To Keep Machinery from Rusting

A formula for an anti-rust compound is made as follows: Dissolve 1 ounce of camphor in 1 pound

of melted lard; take off the scum, and mix in as much fine black lead as will give it color. Clean the machinery, and smear it with the mixture, and after 24 hours rub clean with a soft linen cloth. The machinery will keep clean, under ordinary circumstances, for a long time. JAMES A. PRATT.

White Lead and Tallow

In order to keep white lead and tallow soft in winter and summer alike, so that it can be applied with a brush to finished parts of machinery before shipping them, and for use in fitting keys, etc., prepare a mixture composed of five pounds of white lead and fifteen pounds of tallow. Heat this in a suitable receptacle, and stir until the ingredients are thoroughly mixed. Then remove the mixture to a cool place, and add two quarts of linseed oil, continuing to stir the composition until it becomes cold, as otherwise the white lead with settle at the bottom. This mixture will always remain of the same consistency at all temperatures. R. S. F.

Red-lead Paint for Structural Steel

Structural steel is generally protected from rust by painting. A rust-retarding coat of paint may be suitably compounded from red lead mixed with pure linseed oil. The average stock mixture consists of from 25 to 30 pounds of red lead to a gallon of oil. This mixture can be reduced to the proper consistency at the time of application. A small amount of turpentine added to this brush coating will greatly assist in its manipulation, and will also provide for proper penetration. Red lead should be mixed at

the time of its application, as it settles quite readily, being an extremely heavy pigment.

Removing Rust from Steel—1

Tools which have become very rusty may be treated with a chemical solution, instead of trying to scour the rust off by means of emery cloth. A good solution for removing rust may be made as follows: Into one quart of distilled water dissolve, little by little, sufficient chloride of tin to obtain a saturated solution, that is, until the water will not dissolve any more of the salts. Put the tool into a receptacle containing the solution and let it stand overnight. In the morning rinse the solution off in running water and dry thoroughly with a piece of chamois or cloth.

Removing Rust from Steel—2

A good method for removing rust from steel is to first rub the object with sweet oil, and then, after a day or two, rub it with finely powdered unslaked lime until the rust disappears. Then give it again a coating of oil with a woolen cloth, and put it in a dry place. E. W. Norton.

Removing Rust from Steel—3

It quite frequently happens that parts of machinery having polished surfaces become rusty. This rust is difficult to remove without scratching the highly polished surface. A very effective mixture for removing rust from such surfaces without injury may be made as follows: Ten parts of tin putty (putty-powder or jewelers' putty), 8 parts of prepared buckshorn, and 250 parts of spirits of wine.

These ingredients are mixed to a soft paste, and rubbed in on the surface until the rust disappears. When no trace of rust seems to remain, the surface is polished with a dry, soft cloth.

T. E. O'Donnell.

Removing Rust from Steel—4

Rusted steel can be cleaned by brushing with a paste compound of 1/2 ounce of cyanide potassium, 1/2 ounce castile soap, 1 ounce whiting, and water sufficient to form a paste. The steel should be washed with a solution of 1/2 ounce cyanide potassium in 2 ounces water.

Removing Rust from Steel—5

Rust may be removed from small steel parts such as screws, nuts, pins, etc., when they are not badly pitted, by dipping them into a dilute solution of sulphuric acid. To prepare the acid bath, pour the acid, little by little, into a bowl partly filled with water. After each addition of acid, try one of the rusted parts, and continue trying until the proper strength is obtained to eat the rust off clean. Better results will be obtained in this manner than by working to a set formula. Let the parts remain in the acid bath until cleaned of rust, then remove and wash in soda water, and then in benzine. Finally, dry the parts and brighten in sawdust.

S. W. Green.

Removing Rust from Steel—6

A quick method of removing rust from steel parts, which is not generally known to machinists, is outlined in the following: Rub the surface of the piece

of work from which rust is to be removed with muriatic acid. A convenient way to do this is to dip a match or other small stick into the acid and rub it over the surface of the work. This procedure is continued for several minutes, dipping the stick in as often as necessary to obtain a sufficient quantity of acid. After this treatment has been completed, the work should be washed with a solution of common washing soda and water and then dried in sawdust. This will leave the work free from rust and scratches, but with a dull gray surface. The surface of the metal can be restored to its original color by a little rubbing.

GEORGE GARRISON.

Removing Rust before Electroplating

A simple method of removing rust from surfaces that are afterwards to be electroplated consists in dipping the articles first into a strong hot potash bath, for about half an hour, and then in a cold muriatic-acid pickling solution, composed of 2 parts of water to 1 of acid. This solution removes the rust in a few minutes, leaving the metal apparently attacked but very little. The previous soaking in the strong hot potash solution is responsible for this rapid pickling, as tests have shown that, without previous dipping, 65 minutes is required by the acid bath, against four minutes when previously treated in the potash bath.

Apparently a chemical reaction is set up, changing the character of the rust, softening it, and making it readily soluble. The appearance of the rust as it comes from the potash kettle testifies to this. The pieces that have been treated in the potash bath have a smooth and glossy finish.

Rust-resisting Properties of Iron and Steel

Silicon in iron increases greatly its tendency to corrode; 0.3 per cent of silicon will make iron rust 20 per cent more rapidly than would ordinary iron free from silicon. On the other hand, alloying steel with nickel or copper gives it increased resistance to corrosion; 0.20 per cent of copper in steel produces a material which is attacked by acids at one-tenth the rate of ordinary iron. The corrosion in the atmosphere is only one-third that of iron free from copper. An increase of copper above 0.20 per cent does not add to the corrosion resisting qualities of the iron.

These results have been obtained not merely by laboratory experiments, but in practice. Roofs have been covered in and around Pittsburg with ordinary sheet steel and also with a sheet steel containing 0.20 per cent of copper. The copper alloy roofs were in good condition when the ordinary sheet iron roofs were completely corroded. The results of these experiments also showed that the metals are less attacked in rural districts than in cities, this being due probably to the carbon and acid fumes present in the city atmosphere.

SOLDERS AND SOLDERING

Solder is almost always composed of an alloy of two or more metals. The solder used should have a lower melting point than the metals to be joined by it, but the fusing point of the solder should approach as nearly as possible to that of the metals to be joined, so that a more tenacious junction is effected. Soft solders consist chiefly of lead and tin, although other metals are occasionally added to lower the melting point. Hard solders for brazing are composed of copper and zinc, the composition varying according to the metal to be brazed.

Soft Solder

The fusibility of lead-tin alloys increases with the percentage of tin up to a certain point, but when the tin exceeds 67 per cent, the melting point rises gradually to the melting point of tin. Soft solders are termed common, medium, and fine, according to the tin content, those containing the most lead being the cheapest and having the highest melting points. Fine or "best" solder is largely used for soldering Britannia metal, brass, and tin-plate articles. The soft solder called "common" is used by plumbers for ordinary work, this solder containing two parts of lead to one part of tin. Fine solder is also used for soldering cast iron, steel, copper, and many alloys.

Standard Compositions for Solders

A standard solder of the Society of Automotive Engineers, Inc., contains the following percentages

for Specification No. 1 and Class A solder: Tin, 49.50 to 50.50; lead, approximately, 50.00; antimony, maximum, 0.12; copper, maximum, 0.08; zinc and aluminum, none; other impurities, maximum, 0.10.

It is recommended that the grade of solder be selected that contains the least amount of tin required to give suitable flowing and adhesive qualities for the work at hand. The melting point of this solder is 357.8 degrees F.

Class A solder for Specification No. 3 contains the following percentages: Tin, 39.60 to 40.40; lead, approximately, 60.00; antimony, maximum, 0.12; copper, maximum, 0.08; zinc and aluminum, none; other impurities, maximum, 0.10.

Solder to Withstand Baking Temperatures

The S. A. E. standard solder (Specification No. 4 and Class A) that is recommended for use on work that is to be coated with enamel and then baked, contains the following percentages. Tin, 24.50 to 25.50; lead, approximately, 75.00; antimony, maximum, 0.12; copper, maximum, 0.08; zinc and aluminum, none; other impurities, maximum, 0.10. This solder will withstand higher baking temperatures than solders containing larger amounts of tin.

Hard or Silver Solders

Hard solders, such as are used for silver soldering, and known as *silver solders*, are composed of silver, copper and zinc or brass; whereas hard solders which are used for brazing are alloys formed of copper and zinc. Silver solder is ordinarily applied to the soldering of silverware, jewelry, etc.; parts made of iron, steel, copper, etc., are usually brazed.

The composition of silver solders varies considerably, according to the nature of the work. A silver solder extensively used by jewelers contains 70 parts of silver and 30 parts of copper. Silver soldering is employed for uniting comparatively small parts requiring a strong joint. The heating is usually effected by a blowpipe, and borax or powdered boracic acid may be used as a flux. The flux should be applied before heating, if possible.

A hard solder of low fusing point, which is used extensively by one of the largest electrical companies, is composed of 34.36 per cent of copper; 49.24 per cent of silver; and 16.40 per cent of zinc. Borax is used as a flux.

Other formulas for silver solders are as follows: *Hardest silver solder*: Fine silver, one ounce; shot copper, 120 grains. *Best hard silver solder*: Fine silver, one ounce; shot copper, 105 grains; spelter, 15 grains. *Medium silver solder*: Fine silver, 360 grains; shot copper, 96 grains; spelter, 24 grains. *Easy silver solder*: Fine silver, 336 grains; shot copper, 108 grains; spelter, 36 grains.

Solders for Gold

A solder for gold can be made by melting together in a charcoal fire 24 grains of gold, 9 grains of pure silver, 6 grains of copper, and 3 grains of a good quality of brass. This solder may be used for gold varying from 12 to 16 carats fine. For ordinary gold, the proportion of gold in the composition should be increased. To make the solder darker in color, lessen the proportion of silver and increase that of copper. Other formulas for gold solders are as follows:

Gold solder for 18-carat work: Fine gold, one ounce; fine silver, 144 grains; copper wire, 96 grains (Troy weight).

Gold solder for 16-carat work: Fine gold, one ounce; fine silver, 144 grains; copper wire, 168 grains.

Gold solder for 15-carat work: Fine gold, one ounce; fine silver, 240 grains; copper wire, 240 grains.

Gold solder for 14-carat work: Fine gold, one ounce; fine silver, 300 grains; copper wire, 300 grains.

Solders for Copper, Brass, and Lead

For copper with copper: Copper, 55; zinc, 40; tin, 5.

For copper with iron: Copper, 80; zinc, 16; tin, 4.

For brass: Copper, 45; zinc, 50; tin, 5.

For lead: Lead, 67; tin, 33. J. M. Menegus.

Solder for Small Parts

To make a solder for small metal articles, cut tinfoil into the shape wanted and wet on both sides with sal-ammoniac. Have the surface of the piece clean; place on it the wet tinfoil and then press the parts together firmly and heat until the tinfoil is melted.

E. W. Norton.

Cold Solder

For flux, use 1 part metallic sodium to 50 or 60 parts of mercury. These combine if well shaken in a bottle. For solder, use a weak solution of copper sulphate, about 1 ounce sulphate to 1 quart of water; precipitate the copper by rods of zinc, wash the pre-

cipitate two or three times with hot water, drain off the water and add 6 or 7 ounces of mercury for every 3 ounces of precipitate. A little sulphuric acid will assist in the combining of the matter. The combination will form a paste which sets very hard in a few hours. A. L. MONRAD.

Fluxes for Soldering

In order to obtain a good joint by means of soldering, it is necessary that there be more than mere adhesion between the solder and the metal. There must be an alloy formed between the metal and the solder, and, in order that this alloy may be formed, the surface of the metal must be entirely free from foreign substances, such as oxides, oils, or various kinds of solid matter. This is accomplished by using a flux that melts at the fusing temperature of the solder and thus excludes the air.

The flux used in any case depends somewhat upon the nature of the work. The fluxes generally used for soft soldering are rosin, sal-ammoniac, and zinc chloride, although there are many others employed. For hard soldering or brazing, pulverized borax or boracic acid in powdered form is commonly used. Another flux that has given good results is made of equal parts, by weight, of borax and potash, this mixture being melted and, when cool, pulverized.

Zinc Chloride as a Flux

Zinc chloride has several properties which make it a valuable soldering flux for most work.

Zinc chloride is prepared by dissolving small strips of sheet zinc into muriatic (hydrochloric) acid; the acid should be poured into a glass receptacle, such

as an ordinary fruit jar, and then an equal amount of water added. Next, stir the solution with a wooden stick or piece of zinc (never use iron wire), and then put the strips of zinc in, one at a time.

Care should be taken not to add the zinc too rapidly, as this would cause too violent a chemical action to take place. Continue adding the zinc until the acid will not dissolve any more. Pour a little additional water into the solution and note if the acid again begins dissolving the zinc. If it does not, filter the solution by pouring through filter paper or several thicknesses of clean cloth. Before using the solution it should be diluted with an equal amount of water. In all cases where zinc chloride is used as a flux, the article should be cleaned after soldering to prevent subsequent corrosion of the metal.

Lactic Acid—Ammonium Lactate

Lactic acid and ammonium lactate are good fluxes, equal in every particular to zinc chloride, but in a few hours they cause a tarnish, if used to solder brass or copper. The reason for the ready tarnishing is that lactic acid and ammonium lactate react with copper oxide in the cold. Neither of these fluxes is corrosive or poisonous in any way.

Citric Acid—Ammonium Chloride

An aqueous solution of citric acid is a good flux, having properties very similar to ammonium phosphate. Ammonium chloride is a widely used flux, and is non-poisonous, and does not tarnish copper or brass; but, when used on zinc, it forms zinc ammonium chloride and causes more or less corrosion of the zinc.

Non-spattering Soldering Acid

A very satisfactory soldering acid may be made by the use of the ordinary soldering acid for the base, and introducing a certain proportion of chloride of tin and sal-ammoniac. This gives an acid which is far superior to the old form. To make one gallon of this soldering fluid, take three quarts of common muriatic acid and dissolve as much zinc as possible in it. This, as is well known, is the common form of acid used in soldering. Next dissolve 6 ounces of sal-ammoniac in a pint of warm water. In another pint dissolve 4 ounces of chloride of tin. The three solutions should then be mixed together.

After mixing, the solution may appear cloudy, and can be cleared up by a few drops of muriatic acid, care being taken not to add too much. The acid is used in the same manner as any ordinary soldering fluid. It will be found that it will not spatter when the hot iron is applied, and also that a cheaper grade of solder may be used with it, if necessary.

T. E. O'Donnell.

Non-rusting Soldering Solution—1

A soldering solution for steel that will not rust or blacken the work is made of 6 ounces alcohol, 2 ounces glycerin and 1 ounce oxide of zinc.

A. L. Monrad.

Non-rusting Soldering Solution—2

A good anti-rust solution for soldering metals where acids must not be used is made by dissolving rosin in acetone, making a solution about as thick as molasses; it is applied in the usual manner.

W. R. Bowers.

Non-rusting Soldering Solution—3

To prepare a soldering acid that will not rust iron, add to a saturated solution of zinc and hydrochloric acid 1/4 part ammonia, and dilute the whole with an equal quantity of water. This has been very successfully used on knitting machines, in soldering needles to the holders, where an acid with the above characteristics is essential. J. H. V.

Non-rusting Soldering Solution—4

An economical non-corrosive soldering fluid is the following: Put any quantity of chloride of zinc in a bottle, fill it up with alcohol, and allow it to stand at least 48 hours; then carefully pour off the alcohol, mix it with an equal quantity of glycerin, and shake. The zinc remaining in the bottle can be used until there is nothing left of it, since alcohol, which is poured off after 48 hours, contains all the chloride of zinc that is necessary for good soldering.

HERMAN JONSON.

Solution for General Use

The following solution is inexpensive to prepare, and, in addition to being an excellent soldering solution for brass, copper, tin, and bronze, it may also be used as a flux for soldering galvanized iron. The union between the galvanized parts is perfect when this flux is used. The method of preparing is as follows: Make a saturated solution of zinc chloride by dissolving as much zinc chloride as possible in water. Ammonium chloride (ordinary sal-ammoniac) is added to this, the quantity being 1/10 part by weight. The solution should be thoroughly mixed before using.

Rosin as a Flux

Rosin, either as a powder or an alcoholic solution, is a splendid flux where speed is not required; but it has the undesirable property of leaving a sticky, gummy mass after the evaporation of the alcohol, which is a hindrance in some kinds of work. Often a quantity of carbon and half decomposed rosin is left where the solder is to follow. Rosin is desirable where a non-poisonous flux is required.

Soldering Paste

The requirements of electrical work are such that in some cases an acid soldering flux cannot be used, and it is common practice to use what is known as a *soldering paste.* For soldering copper wires and other electrical conductors, a paste is unequaled and is especially adapted for work in which spattering and corrosion are objectionable.

A soldering paste may be made by mixing a certain proportion of grease and chloride of zinc. The grease commonly used is petrolatum or vaseline, which will give the paste the proper consistency. The proportions should be as follows: Petrolatum or vaseline, one pound, and one fluid ounce of saturated solution of chloride of zinc. Another good paste for use where soldering acid would be objectionable is composed of the following ingredients: Ammonium chloride, 25 per cent; alcohol (wood or grain), 25 per cent; common vaseline, 50 per cent. The ingredients should be thoroughly mixed before the paste is used.

Soldering Aluminum

In a circular of the Bureau of Standards, it is pointed out that all metals or combinations of metals

used for aluminum soldering are electrolytically electropositive to aluminum. A soldered joint is therefore rapidly attacked when exposed to moisture and disintegrated. There is no solder for aluminum of which this is not true. Joints should therefore never be made by soldering, unless they are to be protected against corrosion by a paint or varnish, or unless they are quite heavy, such as repairs in castings, where corrosion and disintegration of the joint near the exposed surface would be of little consequence.

Solders are best applied without a flux or by using paraffin as a flux, after preliminary cleaning and tinning of the surfaces to be soldered. The composition of the solder may be varied within wide limits.

Composition of Aluminum Solder

Solder for aluminum and aluminum alloys should consist of a tin base, with the addition of zinc or both zinc and aluminum, the chief aim being to produce a solder that can be reduced to a semi-fluid state at a suitable temperature for soldering.

A suitable solder for joining aluminum may be composed solely of tin and zinc, the amount of zinc employed ranging, perhaps, from 15 to 50 per cent. Another solder for aluminum consists of a mixture of tin, zinc, and aluminum. In this mixture, the amount of zinc may vary from 8 to 15 per cent, and the aluminum from 5 to 12 per cent, the amount of tin required being determined by the proportions of zinc and aluminum used.

The higher the temperature at which the "tinning" is done, the better the adhesion of the tinned layer. By using the higher values of the recommended zinc and aluminum percentages given, the solder will be

too stiff at lower temperatures to solder readily, and the workmen will be obliged to use a higher temperature, thus obtaining a better joint. A perfect union between solder and aluminum is very difficult to obtain. The joint between previously tinned surfaces may be made by ordinary methods and with ordinary soft solder. Only the "tinning" mixture need be special for aluminum.

Tinning Aluminum

Tinning the surfaces of aluminum preparatory to soldering is an important factor; also, when soldered joints in sheet aluminum are needed, the distance of the overlap of the pieces to be joined should be much less than that usually allowed for other sheet metals. The reason for this is that the solder will not flow into an aluminum joint, even when tinned, by capillary attraction, as it does into tin, brass, or copper joints.

The process of tinning is accomplished by heating the surfaces to be soldered to a temperature somewhat above the fusing joint of the solder used, a satisfactory tinned surface being obtained by rubbing with the point of a well-tinned soldering bit, so as to remove the film of oxide and allow the solder to act upon the clean surface, and in the same motion removing any dross that may have formed.

After the surfaces to be united are thus tinned, they may be soldered together by pressing the tinned surfaces in contact, again heating the metal and solder to the desired temperature, and finally by rubbing thoroughly with the hot soldering bit the surface carrying the liquid solder. In the actual operation of soft soldering aluminum, it is essential

that all joints should be kept under slight pressure until the solder has thoroughly set, this method thus preventing disruption of the joint.

Soldering Bit for Aluminum

An aluminum soldering bit will be found to be far superior to the ordinary copper bit when soldering aluminum, the point and the joint being kept much cleaner during the soldering operation. Another advantage is that the point and slopes of the soldering bit can be tinned with the same flux as that used for the joint; a soldering bit of any other metal has a tendency to discolor the aluminum and to form alloys with the metal and the solder. More care, however, must be exercised in the manipulation of the aluminum soldering bit, because its melting point is lower than that of the ordinary copper soldering bit.

Pointers on Soldering Aluminum

The following suggestions will prove helpful in soldering aluminum:

Remember that the metal cannot be soldered as readily and successfully as other metals.

Never attempt to solder aluminum until the surfaces to which the solder is to be applied have been thoroughly cleaned, as aluminum solders adhere only to bright and clean surfaces.

The surfaces to which it is intended that the solder shall adhere should be thoroughly "tinned."

Before attempting to solder, the metal near the joint to be soldered should be raised almost to the melting temperature of the solder.

Any blowpipe flame that is used for heating must be free from free carbon. A large blowpipe flame should be employed in "heating up" only the parts to be soldered—not on the solder itself. Do not overheat the metal, or its strength will be impaired.

Do not expect the solder to flow with such rapidity as in soldering such metals as tinplate, brass, and copper; aluminum solders generally flow sluggishly.

Avoid wide seams when jointing sheet aluminum. The solder will not flow into the joints, even when tinned, by capillary attraction, as when soldering other sheet metals.

Do not expect the solder to pull the joint together, but see that the joint is kept under a slight pressure until the solder is thoroughly set.

Aluminum solders should not be stored in a damp atmosphere. If kept for some time, the solder deteriorates; hence, when required for use, the metal does not flow so readily.

Spelters for Brazing

Brazing is practically the same as *hard soldering*, but, according to the commonly accepted meaning of the two terms, there is the following distinction: Brazing means the joining of metals by a film of brass (a copper-zinc alloy); hard soldering is the term ordinarily applied when silver solder is used, the latter being an alloy of silver, copper, and zinc.

The spelters employed in brazing are composed of alloys of copper and zinc. The melting point of copper-zinc alloys may be regulated by varying the percentage of zinc, the melting temperature decreasing as the proportion of zinc increases. The fusing point of spelters should be as close as possible to that of the

article to be brazed, as a more tenacious joint is thereby secured.

An easily fusible spelter may be made from two parts of zinc to one part of copper, but the joint will be weaker than when a spelter more difficult to fuse is employed. A readily fusible spelter may be made with 44 per cent of copper, 50 per cent of zinc, 4 per cent of tin, and 2 per cent of lead. Alloys containing much lead, however, should be avoided, since lead does not transfuse with brass and thus decreases the strength of the joint.

A hard spelter for the richer alloys of copper and zinc may be produced from 53 parts of copper and 47 parts of zinc. Brass spelter is sometimes used for copper and iron articles, as these metals have a much higher melting point than brass, thus allowing the use of a richer copper alloy. In these cases tin is often added as one of the ingredients, but it should be sparingly used, as it increases the brittleness of the spelter. Ordinarily, the spelter solder used for brazing is obtained from manufacturers of such supplies. In making brazing spelters, it is important that the metals used should be commercially pure, as impurities interfere with the color, malleability, and strength.

Standard Brazing Solder or Spelter

The S. A. E. standard brazing solder (Specification No. 45) consists of the following percentages: Copper, 48.00 to 52.00; lead, maximum, 0.50; iron, maximum, 0.10; zinc, remainder. This solder starts to melt at about 1560 degrees F., and is entirely melted at approximately 1600 degrees F. It may be used by melting it in a crucible under a flux of borax, with

or without the addition of boric acid, and dipping the material to be brazed into the melted solder. This brazing solder in a powdered form may also be mixed with the flux and applied to the part to be brazed, the melting being done either in a furnace or by means of a brazing torch.

Silver Solder for Brazing

Common silver solder, as applied to brazing, has the advantages of a low melting point and toughness, which are not found to such a high degree in common brazing brasses composed of copper and zinc. The melting point of silver being lower than that of copper, and as it does not oxidize when heated, it is admirably adapted for use in brazing solder. The proper mixture for the solder consists of two parts fine silver filings and one part fine brass, which latter consists of 2 parts copper and 1 part zinc.

T. E. O'Donnell.

The Use of Brass Wire in Brazing

In place of spelter use wire or rod brass and boracic acid as a flux. Anneal the end of wire or rod by heating while the joint is getting hot, and after dipping the rod into boracic acid, apply to the joint; the rod, melting at the end, will flow into the joint. After the joint is cooled, submerge in hot soda water; this will take off every particle of acid, leaving only the brass to be filed off.

F. H. Jackson.

To Braze Steel without Heat

To braze steel without heat, take 1/4 ounce fluoric acid, 2 ounces of brass filings, and 1 ounce of steel filings. Put them all into the fluoric acid. Touch

each part of the work with the mixture, and put them together. Take care that the fluoric acid is put into an earthen vessel. JOSEPH M. STABEL.

Cast Iron Brazing

The ingredients for this cast iron brazing may be had at any first-class drug store. They consist of 1 pound of boric acid, 4 ounces pulverized chlorate potash, and 3 ounces carbonate of iron. These ingredients should be thoroughly mixed, and kept perfectly dry (a glass jar or bottle answering the purpose), and when wanted for use, a small amount should be taken and mixed with grain spelter.

In brazing for the first time, take a piece of cast iron of, say, one square inch cross-section; hold the broken parts together by clamps, and fit the break closely, in order to form a strong joint. Use a gas forge, if possible, but an ordinary blacksmith's forge will do if no gas forge is available. When a blacksmith's forge is used, use charcoal, and be sure to get a high heat. When the pieces of the casting are in place, heat the joint to a good bright red before applying the flux. Then apply it liberally with an iron rod, flattened on the end, and work along the fracture, gradually raising the heat to almost a white heat. Then shut off the heat and allow the casting to cool slowly. If this work is done carefully, the joint will be as strong or stronger than the original casting.

The main points to keep in mind when brazing cast iron are to have the metal clean and free from grease; not to apply the flux until a bright red is reached and then to be sure to raise the heat high enough to make the mixture flow nicely. ETHAN VIALL.

TINNING AND PLATING BATHS

Tinning is the process of covering other metals with a coating of tin. It is used for covering copper and cast-iron household utensils with tin, in order to prevent the acids in food from attacking these metals; and for covering wrought-iron and steel plates and iron castings with a coating of tin in order to prevent oxidation.

Tinning Sheet Steel Parts

When manufactured articles of sheet steel are to be tinned, they must first be thoroughly cleaned from all scale. This can best be done by a pickling solution composed of equal parts of hydrochloric acid (also known as muriatic acid) and water. In some cases, the objects are first sand-blasted. The acid may be kept either in lead tanks or in enameled containers, or in earthenware vessels that are large enough so that a quantity of the parts to be tinned can be immersed in it at once. During the time the articles are in the pickling bath, they should be moved about, so that all parts may be equally exposed to the action of the acid.

Time Required for Pickling

The length of time for pickling will depend upon the temperature and strength of the acid and upon the condition of the surfaces to be tinned. If the acid is fresh, the pickling may be done in about ten minutes, but, if the acid is partly spent, thirty or forty-five minutes will be required.

To obtain a good-looking surface after tinning, the operator should be careful not to "overpickle," as this will cause the articles to look "dead" and "dry." When properly cleaned, the articles should instantly be plunged into a water tank for washing; they are then ready for the flux.

Acid Used without Heating

The acid must not be heated to increase the speed of working, as the surface produced will not be as good as when pickled by cool acid. Any increase of temperature, over that of the atmosphere, required for the effective working of the pickle is soon obtained by the heat generated through the chemical action. If the pickling solution is too hot, the action upon the steel surfaces will not be uniform, and they will be somewhat rough.

Flux for Steel Parts

The flux into which the work is dipped previous to tinning is composed of a solution of chloride (muriate) of zinc, made by dissolving zinc in hydrochloric acid to the saturation point. The steel articles should then be heated slightly before putting them into the molten metal.

The Tinning Bath

The tank used for tinning can be made from cast iron or sheet steel. When preparing the bath of molten tin, sufficient metal should be provided to cover the article to be coated. The tin can readily be melted over an ordinary forge fire, but care must be taken not to overheat it; the temperature should be about 400 or 450 degrees F.

Care should also be taken when immersing the articles to place them gently in the tin bath, as the molten tin coming in contact with the damp surface of the work boils and "spits." The article should be moved briskly in the molten metal by means of a pair of smith's tongs, and then removed quickly and shaken over the bath. When the tin has drained to the lower edges, it should be wiped off with a pad of tow or wadding.

If the coating of tin is not satisfactory after the first attempt, the work should again be dipped in a solution of zinc chloride and then in the tin, as described. A second dip generally improves the appearance of the surface. The work should finally be washed with water and then dried in clean sawdust. The tinned article should now show a smooth coating, uniform in depth and color.

To Obtain a Smoother Finish

A slightly different method used for obtaining a smoother finish on steel parts is as follows: After the articles have been dipped into the tin bath, they are removed and plunged into oil or molten tallow while still hot. They are then redipped into the tin; this second dipping gives a thicker and heavier plate. The oil acts as a flux which gives the tin plating a brighter and smoother finish. After the pieces have been dipped a second time, they are put onto racks to drip until cold.

Tinning Wire Parts

The tinning of wire shapes and stampings, from both hot and cold-rolled stock, has been accomplished

successfully in the following manner: After the pieces to be tinned have been thoroughly cleaned by pickling, they are dipped in a flux made from muriatic acid in which has been dissolved as much zinc as will be held in solution. The work is then ready to be immersed in the molten metal.

The tinning kettle used is 16 by 36 by 18 inches in size. On the molten tin is poured a solution of chloride of zinc in which is dissolved Fines' white sal-ammoniac. The solution is made as follows: To three quarts of chloride of zinc solution, add enough sal-ammoniac to fill a one-gallon receptacle. When this mixture is poured on the molten tin, it spreads all over the metal and keeps the tin from oxidizing. In the course of a five-hour run it begins to become lumpy. The lumps must then be skimmed off and some more of the mixture poured on. One gallon of the solution is sufficient for a ten-hour run. By using this mixture on the molten tin, the tin bath can be kept at a temperature of between 650 and 700 degrees, and the work comes out of the bath bright and without any foreign matter adhering to it.

We have found it necessary, on filling up a tank with new metal, to boil the tin for from three to four hours, using raw potatoes, which are held at the bottom of the kettle in a basket. The moisture from the potatoes boils up through the molten tin and removes any impurities.

After such experimenting, we have found that the best medium for washing stampings after tin-coating is a soap solution consisting of from four to five pounds of soap chips to one hundred gallons of rain water. This solution is kept boiling by means

of a steam coil. Kerosene will give a somewhat brighter finish, but for our regular work we employ the soap solution with excellent results.

AXEL HALVORSEN.

To Test Galvanized Wire

Wire may be subjected to the following test, in order to determine if it is well galvanized. The wire is plunged into a saturated solution of sulphate of copper (blue vitriol), and permitted to remain in this for one minute, after which it is wiped clean. This process is repeated four times. If the wire appears black after the fourth immersion, it shows that the zinc has not all been removed, and that the galvanizing has been well done; but if it has a copper color, the iron is exposed, showing that the zinc coating is too thin.

O. G.

Tinning Cast Iron

Before tinning cast iron, the castings must be absolutely clean and free from sand or oxide. The scale or oxide must be removed so that clean metal will be exposed to the tin. The cleaning is accomplished by passing the castings through a "rattler," which removes a great deal of the scale. The castings are then placed in a pickling solution of dilute hydrochloric (muriatic) acid until a clean surface is obtained. This pickling bath is warmed by means of a steam jet to a temperature of about 150 degrees F.

Care must be taken during the pickling process to keep the surfaces in the bath from coming in contact with each other, as this would prevent the acid from doing its work. The work should be examined

occasionally while in the pickle, and any sand or black spots should be removed by means of a stiff wire brush. "Overpickling" pits the castings, and care must be taken to avoid it. The length of time of pickling will depend upon the temperature and strength of the acid, and upon the condition of the casting surfaces.

Baths Used before Tinning

After being thoroughly cleansed, the castings should be immersed in a tank of clean water. If it is desired to keep the cleansed castings for any length of time, they may be preserved from oxidation by being left under the water until they are ready for the tinning bath.

When the tinning bath is ready (only the best block tin should be used), the castings should be immersed in a boiling solution of caustic soda or potash, for about two minutes, then rinsed in water, and then in a bath consisting of a weak hydrochloric (muriatic) acid solution (1 in 40).

The next step is to immerse them in muriate of zinc solution (zinc chloride). This is made by dissolving zinc in muriatic acid to the saturation point, and to every gallon of this solution, adding five pounds of sal-ammoniac.

Tinning Baths for Cast Iron

The castings are next immersed in the first tinning bath at 500 degrees F. Great care should be taken not to let the tin become red hot, as undue heating would spoil the surface of the casting, giving it a "dry" appearance; at the same time it accelerates

the formation of dross. The bath should have a special flux on the surface, prepared by boiling muriate of zinc on top of the tin and adding thereto some sal-ammoniac. The proper consistency of this flux is essential to good work. If it tends to become thick or hard, add more of both ingredients, and remove any hard part with a skimmer.

The castings next go to the second tinning bath. Care should be taken that none of the surface slag or flux is taken by the work into this bath. The bath should have a layer of tallow on the top, to a depth of 1/2 inch. When the castings have been withdrawn from the bath, they may be thrown into a clean sawdust receptacle, which takes up the oil. The operation of tinning is now complete.

The molten tin in the bath should always be cleaned of all impurities. This can be done by taking a piece of green or wet wood secured to a pointed iron rod, and fastening it so that the wood will be kept at the bottom of the pot of the molten metal for one or two hours, depending upon the amount of impurity in the metal. The surface of the metal is skimmed by means of a perforated iron skimmer.

Cold Tinning

Cold tinning is a process for providing iron or steel with a protective covering of tin without melting the metal. The metal to be tinned is first thoroughly cleaned, preferably by some abrasive material, and it may then be rubbed with a coarse cloth dampened with hydrochloric acid. A soft amalgam of tin is next applied with the same cloth, after which the mercury in the amalgam is driven off by heating the tinned object.

Cold Tinning Brass or Steel

To tin by cold process finished work in iron, brass, or steel, such as pins, tacks, wire goods, etc., put twenty pounds of stock well cleaned in sawdust, in a deep pan (14 x 20 x 3 inches is a good size) having a false bottom of zinc. Heat to the boiling point a mixture of 1/4 ounce of sulphuric acid and 2 ounces of tin crystals (stannous chloride) and pour over the work. Let it stand ten minutes and then stir well, using a rake, and then let it remain ten minutes longer. Repeat the process, and if two coats are not enough, give it a third coat. The zinc bottom must be washed twice a day, as rusty or oily work will not tin satisfactorily.

To polish the work, put in a wooden tumbling barrel and pour in a water pail full of strong soap and water. Let it tumble fifteen or twenty minutes, according to the nature of the work, and then tumble for a few minutes in hot sawdust to dry it.

J. L. Lucas.

Tinning Wash for Brass Work

To prepare a tinning wash for brass work, use 6 pounds of white argil (potter's clay), 4 gallons of soft water, and 8 pounds tin shavings. Boil the brass work in this solution for 15 or 20 minutes.

W. R. Bowers.

To Tin Brass or Copper

To tin brass or copper, melt 5 pounds of tin and pour it into a tank containing one ounce of cream of tartar in about 8 gallons of water. This must be done a drop at a time, to subdivide the tin, so as to

give a larger surface for the cream of tartar to act upon, and have the bottom of tank covered with tin. Then put a fire under the tank and place parts to be tinned in the tank and let them boil for about one hour, or until they are coated sufficiently.

H. C.

Copper-plating Cast Iron

In the process of covering cast iron with a coating of copper, the pieces of cast iron are first placed in a bath made of 50 parts of hydrochloric acid, specific gravity 1.1, and one part of nitric acid; they are next immersed in a second bath comprised of 10 parts nitric acid and 10 parts chloride of copper dissolved in 80 parts of hydrochloric acid, specific gravity 1.1. The pieces are then rubbed with a woolen cloth and immersed again until the desired thickness of copper is deposited. To give a bronze appearance, the copper surface is rubbed with a mixture of 4 parts sal-ammoniac and one part each of oxalic acid and acetic acid dissolved in 30 parts of water. A. L. Monrad.

Brass-coating Solution

To coat with brass small articles of iron or steel, drop them into a quart of water and 1/2 ounce each of sulphate of copper and protochloride of tin. Stir the articles in this solution until the desired color is obtained. R. M.

Brass-coating Iron or Steel

Iron or steel may be given a permanent coating of yellow brass by using a flux of boracic acid and then dipping into a pot of melted spelter, afterwards wip-

ing off the article while still hot. The electroplating process, however, is the best for this purpose. A coating of copper should then first be deposited on the steel, the same as if it were to be nickel-plated, and then followed with an electroplating of yellow brass.

L. MILLER.

Nickel-plating Brass and Copper

The following formula for "nickel-plating" brass and copper parts has proved very satisfactory. In using this method, the first step is to see that the parts to be plated are quite clean and free from grease. The work is then dipped in a saturated solution of bichloride of mercury, or else a paste is applied by rubbing. This treatment causes a film of mercury to be deposited on the work, and when this result has been obtained the pieces are dried in sawdust and then lacquered in the usual way.

If a paste is found more convenient to use than the solution, it may be prepared by adding water to the powdered bichloride of mercury, to obtain the required consistency. It is essential that the parts be lacquered after they have been plated in this way; otherwise, the mercury will wear off in a short time.

Bichloride of mercury may be obtained at almost any drug store, but it may be prepared by allowing metallic mercury to dissolve in hydrochloric acid until the strength of the acid is used up. The liquid is then boiled off, leaving white crystals of bichloride of mercury in the vessel. Either a glass or earthenware vessel should be used to prepare the bichloride of mercury, as hydrochloric acid will act upon any metal vessel which may be used.

GEORGE GARRISON.

Electroplating Baths

Electroplating is the art of making electrolytic depositions of one metal on another for the purpose of improving the appearance of the metal covered, or the wearing qualities, or both. In order to deposit one metal on another in a smooth, firmly adhering layer, the surface to be covered must be perfectly clean (See Pickling and Cleaning Baths).

Cleaning and plating simultaneously in the same solution, subsequent to polishing, is now widely practiced, especially to give iron and steel a preliminary coating of copper before nickel-plating. It has the advantage of saving time and labor in changing the articles from one solution to another, and any failure of the solution to remove the grease is shown, while the object is still in the cleaning solution, by the failure of the copper to completely cover the iron.

The following solution may be used for the simultaneous removal of grease and deposition of brass on the cleaned surface: 1/2 pound of Hanson & Van Winkle's "XXX" lye; 2 ounces of copper carbonate; 2 ounces of zinc carbonate; 4 ounces of ammonium carbonate; 4 ounces of potassium cyanide, and 1 gallon of water. The solution is used boiling.

Nickel-plating Solution

Nickel is usually plated from a solution of nickel ammonium sulphate, with some ammonium sulphate added to increase the conductivity of the solution. The bath may be made up of the following composition: Nickel-ammonium sulphate, 17 ounces; ammonium sulphate, 17 ounces; water, 10 quarts. The solution should be just acid enough to redden blue litmus paper. If too acid, ammonia may be added;

if not acid enough, a solution of citric acid or sulphuric acid may be gradually added until litmus paper is slightly reddened. Boiling water may be used to dissolve the salts more rapidly.

This bath requires about 2 volts, and the proper current density is about 5.5 amperes per square foot. The deposit of nickel, and of other metals also, is more adhesive when a higher potential, for example, 6 volts, is used for the first 30 seconds. This may be obtained by reducing the resistance of the rheostat in series with the plating tank. This bath is used at room temperature, and deposits of 0.0004 inch may be obtained without danger of the nickel peeling off; if thicker deposits are required, the bath must be heated to from 160 to 190 degrees F.

By making the bath more concentrated, higher current densities may be used, and good deposits of 0.04 inch may be obtained in a relatively short time. With a solution containing from 5 to 12 ounces of nickel sulphate in 1 quart of water, to which some ammonium sulphate may or may not be added to increase the conductivity, a current density of from 20 to 70 amperes per square foot may be used.

Black-nickel Solution

From some solutions, the nickel deposit is black; this method of plating is employed, to a certain extent, but it has the reputation of being a troublesome process. A solution that is said to give the best results is composed of the following: Water, 1 gallon; nickel-ammonium sulphate, 8 ounces; ammonium sulphocyanate, 2 ounces; zinc sulphate, 1 ounce. This solution is used at ordinary room temperature and about 1 volt is applied. As soon as the

surface is black, which requires from 20 to 60 minutes, the plating must be stopped. When finished, the surface must always be lacquered.

Cobalt-plating Solution

Plating with cobalt is superior to nickel-plating, in a number of ways. The following solution is recommended: Cobalt sulphate, $CoSO_4$, 10.4 ounces; sodium chloride, NaCl, 0.65 ounce; boric acid, nearly to saturation; water, 1 quart. The advantages of plating with this solution are as follows: A high current density may be used, from 32 to 240 amperes per square foot, so that a commercially satisfactory plate can be obtained in three minutes; an hour is required in the usual nickel-plating baths. The deposit takes a high polish that is even more pleasing in appearance than nickel, and is white with a slightly bluish cast. It is much harder than nickel deposits and, consequently, thinner deposits may be used.

Copper-plating

Plating with copper is usually for the purpose of preparing the more electropositive metals, such as zinc, iron, and tin, for the process of nickeling, silvering, or gilding; more rarely to protect them from oxidation, or for decoration. Acid copper solutions cannot be used for plating metals more electropositive than copper, because, as soon as such a metal is dipped into the solution, copper is deposited on the metal, usually in a loose powdery form that peels off. Alkaline baths are, therefore, used, which generally contain potassium cyanide.

The following bath gives good results: Water, 10 quarts; carbonate of soda, crystallized, $Na_2CO_3 + 10$

H_2O, 8 1/2 ounces; sodium sulphite, crystallized, $Na_2SO_3 + 7\ H_2O$, 7 ounces; acetate of copper, $Cu(C_2H_3O_2) + H_2O$, 7 ounces; potassium cyanide, KCN, 98 to 99 per cent, 8 1/2 ounces. When making up this solution, dissolve the carbonate of soda in 7 quarts of warm water, then gradually add the sodium sulphite, then the copper acetate, when stirring. Dissolve the potassium cyanide in 3 quarts of cold water and add to the first solution, when it has become cold; the resulting solution should be colorless or light yellow. The current density on the cathode is about 2.7 amperes per square foot; about 3 volts is required. Cyanide baths are frequently used at from 140 to 160 degrees F.

Brass-plating Solution

Brass may be deposited electrolytically from cyanide solutions of copper and zinc, using brass anodes; in the course of time, these anodes are covered with a greenish slime. Copper and not brass would be deposited from acid solutions of copper and zinc. These two metals can be deposited simultaneously only from solutions of complex salts, such as potassium copper cyanide, $KCu(CN)_2$, and potassium zinc cyanide, $K_2Zn(CN)_4$. Brass deposits are made to improve the appearance of iron objects and in place of copper as a preparation for depositing other metals.

A good brass bath is made by dissolving 8.4 ounces of crystallized copper acetate, $Cu(C_2H_3O_2)_2 + H_2O$, and 10.8 ounces of zinc acetate, $Zn(C_2H_3O_2)_2 + 3\ H_2O$, in 10 quarts of water, and then mixing with a solution of 2.4 ounces of potassium cyanide, KCN, 1.7 ounce of sodium sulphite, $Na_2SO_3 + 7\ H_2O$, and 6.7 ounces

of sodium carbonate, Na_2CO_3, in 10 quarts of water. The best current density is between 2.8 and 4.6 amperes per square foot. The deposit contains relatively more copper and less zinc than the solution; consequently, an occasional addition of copper to the bath will be required. A fresh brass bath is likely to work irregularly at first, but, after using for a few hours or days, a good deposit is obtained.

Bronze-plating Solution

Bronze is an alloy of copper and tin. Plating with bronze is seldom carried out, as it can be imitated by brass with a larger content of copper. A bronze bath may be made by dissolving, at from 122 to 140 degrees F., 2.11 ounces of cyanide of copper, CuCN, and 0.7 ounce of oxide of tin in 10 quarts of potassium-cyanide solution, at 4 degrees Baumé, and then filtering the solution. Cast-bronze anodes are used. A recommended formula is as follows: Dissolve 3.3 ounces of copper sulphate and add 7 ounces of potassium cyanide and 4.7 ounces of potassium hydrate. In another portion of water, dissolve 2.5 ounces of potassium oxalate and 5.5 ounces of potassium-tin chloride; mix the two solutions and dilute to 1 gallon. The current density of the cathode is from 10 to 20 amperes per square foot, and the temperature is 104 degrees F.

Bath for Tin-plating

Tin may be plated satisfactorily from the following bath: 3.5 ounces of pyrophosphate of soda; 0.35 ounce of fused stannous chloride; and 10 quarts of water. The current density is 2.3 amperes per square foot. Tin may be deposited directly on zinc, copper,

or brass; iron and steel must first be copper-plated if this bath is used. With the following bath, iron and steel may be tin-plated without a previous plating of copper: 7 ounces of crystallized ammonium alum; 28 drams of crystallized stannous chloride; 2.8 drams of fused stannous chloride; and 10 quarts of water. The ammonium alum is dissolved in hot water and then the tin salts are added; the bath is used when boiling. It must be kept at its original strength by the addition of stannous chloride, because, even if tin anodes are used, they do not dissolve with 100 per cent efficiency.

Zinc-plating Solution

Zinc-plating is largely used to protect iron objects from rust. For this purpose, it is much more efficient than the zinc coverings produced by hot galvanizing, although the latter have the more pleasing appearance. Zinc affords better protection to iron from rusting than tin, because it is more electropositive to iron, while tin is electronegative. In brief, the process consists in immersing the carefully pickled and cleaned parts in a solution composed essentially of zinc sulphate, with a very slight amount of free sulphuric acid. Various organic substances are also added to assist in the production of a smooth, dense deposit. There is a large number of formulas for these baths, many of which are patented or secret.

Bath for Zinc-plating

The following bath made from pure materials may be used: Crystallized zinc sulphate, $ZnSO_4 + 7\ H_2O$, 66.7 ounces; crystallized sodium sulphate, $Na_2SO_4 + 10\ H_2O$, 13.3 ounces; zinc chloride, $ZnCl_2$, 3.4 ounces;

crystallized boric acid, H_3BO_3, 1.7 ounces; water, 10 quarts. Zinc anodes are used. All zinc baths work better when heated to from 100 to 120 degrees F., which increases the conductivity of the solution and causes a more uniform deposit on uneven surfaces.

With current densities between 4.6 and 18.5 amperes per square foot, and temperature from 64 to 122 degrees F., bright gray deposits of zinc up to a thickness of 0.002 inch may easily be obtained in this bath. The bath must be kept acid by the addition of enough sulphuric acid to cause Congo paper to be colored slightly blue by the solution.

Silver-plating

From cyanide baths, which are universally used for silver-plating, the deposit is smooth, coherent, and of a milk-white color, which, on polishing, takes the appearance of ordinary silver. The bath may be made as follows: Potassium cyanide, 98 per cent, from 6 1/3 to 7 ounces; potassium silver cyanide, crystallized, $KAg(Cu)_2$, 17 1/2 ounces; distilled water, 10 quarts. The current density is from 1 to 4.2 amperes per square foot, at about 1 volt, and pure silver anodes are used.

Silver is deposited only on surfaces of copper or of copper alloys; if other metals are to be silver-plated, a layer of copper or brass is first produced, and the silver is deposited on this. After this surface has been cleaned and pickled, it is amalgamated by immersing in a quickening solution, which is made as follows: Potassium mercury cyanide, 0.9 ounce; potassium cyanide, 0.9 ounce; water, 1 quart. The object remains in this solution only long enough to acquire a uniform white coating of mercury; then rinse in clean water and place in the silver bath.

In order to make the silver adhere more firmly, the object is plated first for a few seconds in a striking solution with a relatively high current density, and then finished in the bath just given. The striking solution is as follows: Potassium cyanide, 6 ounces; potassium silver cyanide, 0.9 ounce; water, 1 gallon. It is advantageous to agitate the solution by keeping the articles in motion while in the bath.

Gold-plating

Gold is universally plated from a solution of potassium gold cyanide, $KAuC_2N_2$ held in solution by potassium cyanide. The appearance of the deposited gold depends upon the temperature of the bath. A hot bath gives deposits of greater density and uniformity, and richer tones. Any other metal than copper must be copper-plated before gilding. The following bath is suitable for cold gilding: 54 grains of gold in the form of fulminating gold, from 0.35 to 0.5 ounce of 98 per cent potassium cyanide, and 1 quart of water.

Fulminating gold is prepared by adding ammonia to a solution of gold chloride. The fulminating gold is precipitated, filtered, and washed, and then dissolved in potassium cyanide, while still moist; if dried, it is highly explosive. Too much potassium cyanide causes the gilding to be pale.

The following bath is suitable for hot gilding: 15.4 grains of gold in the form of fulminating gold; 77 grains of 98 per cent potassium cyanide; and 1 quart of water. The temperature is from 158 to 176 degrees F. The current density used in gold-plating is from 0.93 to 1.4 amperes per square foot at from 1 to 3 volts; the anodes are of fine gold. When very large objects are to be gilded, anodes of correspond-

ing dimensions are required in order to insure a uniform current density. As it would be too expensive to use large gold plates, carbon may be substituted.

Electroplating Zinc-alloy Die-castings

Difficulty has sometimes been experienced in electroplating zinc-alloy die-castings, although they can be electroplated as easily as iron or steel, if the proper methods are followed. The following information, abstracted from a booklet on this subject issued by the National Lead Co., contains some practical methods whereby die-castings can be cleaned, polished, and electroplated.

Cleaning and Polishing Die-castings

Die-castings that are to have a polished surface should be "cut down" with the usual buff wheels and tripoli composition. The finishing should be done with white compositions of Vienna lime. After the parts have been polished, the excess of polishing material should be removed by the aid of benzine or gasoline, and they should be dried in maple sawdust. If the benzine or gasoline is dispensed with, hot alkaline solutions should be used for cleansing.

The strong alkalies of caustic soda or potassium should be used with caution in cleaning zinc, as they act rapidly upon the metal and produce oxides, thus destroying the polished surface. The solution should be maintained at a temperature of from 160 to 180 degrees F. Soda ash may also be used for the purpose, 1 pound of soda ash and 1/4 ounce of cyanide of potassium being used to 1 gallon of water.

The articles should remain in the cleansing bath for a few minutes and then the excess polishing material brushed away, using an oval painter's sash

brush for the purpose; the "rubber-set" variety is the most economical. After cleansing, immerse in clean, cold water and then into a cyanide dip. This dip should consist of 6 ounces of cyanide of potassium or sodium to each gallon of water and should be used cold. After rewashing the articles in clean, cold water, they are ready for the plating bath.

Copper-plating Die-castings

The solution for copper-plating should have the following composition: Water, 1 gallon; cyanide of copper, 3 ounces; carbonate of potash, 1 ounce; cyanide of potassium or sodium, 4 ounces. To prepare the solution, the potash and copper should be dissolved in half the amount of hot water, the cyanide in the balance of luke-warm water; then thoroughly mix together. Use the solution at a temperature of 150 degrees F. and at from 2 to 2 1/2 volts pressure. Cast-copper anodes give the best results, but the electrolytic variety may be used.

Brass-plating Die-castings

Prepare a solution exactly the same as for the copper bath; then dissolve equal parts of cyanide of zinc and cyanide of potassium in warm water. An addition of 1 ounce of zinc carbonate and the same proportions of cyanide per gallon of solution should be added to the copper bath; then add 1/2 ounce of sal-ammoniac per gallon of solution. If the color should be too deep a yellow, a little more zinc should be added to the bath to obtain the required shade. This bath should be used at a temperature of 120 degrees F. and at from 2 to 3 volts pressure. The cleansing of the articles should be done as previously stated.

Nickel-plating Die-castings—1

Much trouble has been experienced in nickel-plating die-castings with the ordinary solution, due to black streaks appearing in the deposit caused by local action of the ordinary solution upon the metal. The following formulas will give satisfactory results without the difficulties mentioned: Nickel sulphate, 10 1/2 ounces; potassium citrate, 7 ounces; ammonium chloride, 10 1/2 ounces; water, 2 1/2 gallons. To prepare this bath, dissolve the nickel sulphate and ammonium chloride in half the amount of hot water prescribed; then dissolve the potassium citrate in the balance of the water and mix thoroughly. The voltage should be from 2 1/2 to 3 volts. This bath should always be kept neutral so as to avoid black streaks. For this purpose pure caustic potash dissolved in water should be added to the bath so that the solution is neutral to the test of red or blue litmus paper.

Nickel-plating Die-castings—2

The following bath is used extensively in nickel-plating articles made from zinc, and gives excellent results: Double nickel salts, 8 ounces; chloride of sodium, 1 ounce; magnesium sulphate, from 2 to 4 ounces; water, 1 gallon. To prepare the bath, dissolve the nickel salts in half of the water at a temperature of 180 degrees F., and dissolve the other salts in the balance of cold water; then thoroughly mix together. Use this solution cold, with anodes of cast nickel. The voltage should be from 2 1/2 to 3 1/2 volts. The articles to be nickel-plated may be plated directly or be lightly coated in the copper or brass baths prior to nickel plating. The time of im-

mersion in either of the nickel baths should be according to the thickness of the deposit required, although 30 minutes gives a fairly good deposit in either case.

Silver-plating Die-castings

For this purpose, the following solution is used: Cyanide of silver, 3 ounces; cyanide of potassium, 4 ounces; water, 1 gallon. Use anodes of pure silver at about 1 volt pressure. Die-castings for silver-plating should be previously copper-plated for a short time, then amalgamated in a mercury dip consisting of the following proportions: Water, 1 gallon; oxide of mercury, 1/2 ounce; cyanide of potassium, 6 ounces.

After copper-plating and washing in water, the articles are immersed in the dip for a second or two, or until uniformly coated with mercury. They should then be rewashed and immersed in the silver bath. The articles may also be nickel-plated in one or the other of the nickel baths and then quickly coated in the silver striking solution, after which they should be directly immersed in the silver bath without rinsing.

The silver strike should be as follows: Cyanide of silver, 1/2 ounce; cyanide of potassium, 6 ounces; water, 1 gallon.

Use silver anodes with from 3 to 4 volts pressure. The nickel surface must be immediately coated over for successful silver deposits.

Gilding Die-castings

In gilding die-castings, the articles must be previously coated with brass or copper and have a

bright luster. The following formula will give good results: Phosphate of soda, 8 ounces; sulphate of soda, 1 1/2 ounces; cyanide of sodium, 6 pennyweights; chloride of gold, 6 pennyweights; water, 1 gallon. To prepare the solution, dissolve the cyanide and chloride of gold in part of the hot water and the sodium salts in the balance; then mix together thoroughly.

Anodes of gold, platinum, or carbon may be used, and the bath should be kept at a temperature of 180 degrees F. at 2 volts pressure. If the articles are previously coated in the copper bath, they should afterward be flashed in the brass bath to save an excess of gold. The usual lacquers should be applied to brass, copper, silver, or gold finishes. In plating die-castings or articles of zinc, it is a distinct advantage to use as little free cyanide as possible.

To Plate Porous Work

In the plating of brass or cast iron, or other porous metals, there is more or less trouble with what is called "spotting out", which is caused by the cyanide getting into the pores, and it has been hard to find a satisfactory remedy for this trouble. The following can be used with good results: First, give the work a good stiff coat of nickel, then put it through a brass solution without buffing. After the required deposit has been obtained, rinse it in cold water, and then hang in boiling water as long as possible without tarnishing. Then hang it in a good hot oven until thoroughly dried out, after which buff and hang for a few moments in gasoline, and put it in the oven again. This will cure a great deal of the trouble.

J. L. LUCAS.

Removing Spoiled Nickeling

While in many cases nickel-plated articles are so cheap that it would not pay to remove the nickeling if this did not turn out well, this would sometimes be found desirable. For articles made of brass, copper, German silver or Britannia metal, an acid bath may be used to remove the plating. The requisite bath consists of 27 parts, by measure, of oil of vitriol (fuming sulphuric acid) and 18 parts of nitric acid. The articles to be cleansed must first be freed from fat by dipping them in lye, the same as for newly plating. This assures regular action of the acid bath. The article is moved about in the latter until all the nickel is dissolved; it is then rinsed first in hot and afterwards in cold water. The acid attacks the base, also, but polishing will restore its original appearance. For iron and steel articles, abrade the coating with emery powder and then proceed as usual to replate.

VARNISHES AND PAINTS

Ordinary varnish is a liquid consisting of a gum or rosin dissolved either in alcohol, in which case it is known as spirit varnish, or in oil, when it is known as oil varnish. Varnish is used in the mechanical trades in patternmaking, and also for covering various metal parts. Receipts for certain special varnishes and paints follow.

Varnish for Steel

A good varnish for steel may be made by dissolving 10 parts of clear grains of mastic, 5 parts of camphor, 15 parts of sandarac, and 5 parts of elemi in a sufficient quantity of grain alcohol. Apply the varnish without heat. JOS. M. STABEL.

Varnish for Iron Work

To make a varnish for outdoor wood and ironwork, dissolve in about 2 pounds of tar oil 1/2 pound of asphaltum and a like quantity of pounded rosin; mix hot in an iron kettle, care being taken to prevent any contact with the flame. When cold the varnish is ready for use. JOSEPH M. STABEL.

Black Varnish for Metals—1

A good black varnish for cast iron and forgings can be made of 1/4 pound lampblack; 1/2 pound rosin; 1 pound asphaltum; 1 quart turpentine spirits; and a small quantity linseed oil. The lampblack is first rubbed up with the linseed oil, no more oil being used than necessary for this purpose. The other ingredients are then mixed with it thoroughly.

O. G.

Black Varnish for Metals—2

A good varnish for finishing metals can be made by mixing 1,000 parts of benzine, 300 parts of pulverized asphalt, and 6 parts of pure India rubber, to which is added enough lampblack to give the desired consistency to the mixture. H. A. SHERWOOD.

Varnish for Cast-iron Patterns

For small cast-iron patterns the following is a very satisfactory method of varnishing. Apply boiled linseed oil to the iron, the pattern being heated to a temperature that will just char or blacken the oil; the oil appears to enter the pores of the iron, and after such an application the metal resists rust and corrosive agents very satisfactorily.

JAMES A. PRATT.

Varnish for Wood Patterns

Patterns intended for repeated use are varnished to protect them against moisture, especially when in damp molding sand. The varnish most generally used is the yellow shellac varnish, which is made by dissolving gum shellac in grain alcohol. Wood alcohol may also be used for this purpose, but it produces an inferior varnish. A good varnish dries quickly and produces a very smooth surface. At least three coats of varnish should be applied to patterns, the surface of the pattern being rubbed down with sandpaper before varnishing and between applications.

Coloring Varnish

Varnishes may be given color by the addition of various coloring agents. Colored varnishes are used

for covering core prints, in order to readily distinguish the prints from the body of the pattern. Black shellac varnish is made by the addition of lampblack. Red varnish can be made by adding Chinese vermilion. Coloring powders must be well pulverized before adding them to the varnish.

Occasionally the shellac varnish used by the patternmaker loses its clear, amber tint. Any desired depth of tint may be obtained readily by the addition of a small quantity of gamboge previously dissolved in a small quantity of alcohol.

Varnish can be "paled" by adding 2 drams of oxalic acid per pint of varnish; it can be colored red with dragon's blood; brown, with logwood or madder; and yellow, with aloes or gamboge, each dissolved in spirits and strained.

To Clarify Shellac Varnish

Even with the best of care, the patternmaker will find that shellac often leaves dirty streaks on the pattern from various impurities held in suspension in the varnish. These may be entirely precipitated by the gradual addition of some crystals of oxalic acid, stirring the varnish to aid their solution, and then setting it aside overnight to permit the impurities to settle. No more acid should be used than is really necessary.

OSCAR E. PERRIGO.

To Mix Lampblack and Shellac

In mixing lampblack and shellac, the tendency is to form lumps when the two are mixed by throwing, or even sifting the former into the latter. The lumps can be reduced and an intimate mixture obtained with a paddle or pestle, but this requires too much

time. The whole difficulty is easily avoided if the lampblack is first wet with alcohol and thoroughly worked down into a soft paste with a paddle or spatula. The black paste is then added to the shellac and mixed uniformly by stirring. The result is a smooth flowing and working shellac. Other pigments can be treated in the same way. O. M. B.

Varnish for Drawings—1

Dissolve by low heat 8 ounces of sandarac in 32 ounces of alcohol. Another receipt is: Dissolve 2 pounds of mastic and 2 pounds of a lammar in 1 gallon turpentine, without heat. The drawings must first be sized with a strong solution of isinglass and hot water. W. R. Bowers.

Varnish for Drawings—2

The appearance of varnished blueprints and drawings may be greatly improved and the amount of bleached shellac varnish considerably decreased by the following process: Soak overnight a quantity of isinglass in just enough cold water to cover it. Use a perfectly clean glue kettle, in which it is to be heated up, adding whatever amount of water may be needed to make a moderately thin sizing. Apply this warm, *not* hot, to the drawing or blueprint. When dry, apply one good coat of bleached shellac varnish.

Metal Varnish to Withstand Exposure

Varnish is sometimes used for covering metal parts that are to be exposed to weather conditions. Munitions of war, such as shrapnel and high-explosive shells, are frequently varnished, and the cartridge

cases used in connection with such shells are varnished both on the inside and outside. Varnish, for this purpose, must be of a very high quality. The following compositions of varnishes for covering metals are recommended: Fine orange shellac, 21 parts; methylated spirit, 79 parts. The specific gravity of this varnish is about 0.885. Another varnish consists of fine orange shellac, 8 parts; seedlac, 4 parts; turmeric, 29 parts; methylated spirit, 59 parts. The specific gravity of this varnish is about 0.865. A lacquer or varnish also used is made from seedlac, 11 parts; turmeric, 5 parts; methylated spirit, 84 parts. The specific gravity of this lacquer is 0.85.

Testing Metal Varnish

High-grade varnishes used on metal should not show any impression if scratched with a wooden point or with the finger-nail. When scratched with a metallic point, the varnish should not crumple and should not show any cross-cracks. When applied to a metal object, varnish should not alter its appearance if placed in water for twenty-four hours, and, when removed from the water and dry, the varnish should adhere so firmly to the metal surface as not to be removable under the pressure of the finger. After heating the varnished metal object for twenty-four hours in a water bath, at a temperature of 167 degrees F., the varnish must not peel off. Brass covered with varnish must not show any oxidizing action.

Paint for High Temperatures

Paint that will withstand high temperatures, even up to a red heat, has the following composition:

Lampblack, 3 pounds; graphite, 3 pounds; black oxide of manganese, 1 pound; Japan gold size, 1 pint; turpentine, 1.5 pint; and boiled linseed oil, 1 pint. Powder the graphite and mix all the ingredients to a uniform consistency; give two coats. The following mixture is also recommended: Black oxide of manganese, 2 pounds; graphite, 3 pounds; and terra alba, 9 pounds. Mix and pass through a fine sieve, then mix to the required consistency with the following compound: Sodium silicate, 10 parts; glucose, 1 part; and water, 4 parts.

Zinc Paint for Oily Surfaces

An excellent zinc paint for any surface coming in contact with either hot or cold oil, consists of 25 pounds oxide of zinc, 3 gallons gloss oil, and 1 quart linseed oil, cut with turpentine, and bleached with ultramarine blue. The surface to be covered should be absolutely free of all greasy or oily substances; if proper care is taken, the paint will not crack and will retain its pure white appearance indefinitely. The paint can be blown into water jackets of bearings, to fill the sand holes. This paint dries rapidly, and will be found effective for the purpose.

Marking Paint for Machine Parts

In shops making a business of repairing machinery, it is generally necessary to mark the parts of machines in some way so that they may be properly reassembled. This is especially true in railway shops, where the marking is necessary more for the purpose of distinguishing the parts of different engines. The best way to mark such parts is to stamp them with steel dies; but this is not always practicable,

and, in the absence of such means of marking, use a marking paint made of white lead mixed with turpentine to a thin consistency. Such paint dries quickly and when dry is not easily removed. It has the advantage of showing up fairly well on greasy surfaces, but it is better that the surfaces to be marked should be well cleaned with kerosene oil before marking.

F. EMERSON.

Waterproof Marking Paint for Stone

To prepare a marking paint for use on stone where exposed to the water and dampness, use pitch, 11 pounds, lampblack, 1 pound, and heat carefully, adding sufficient turpentine to give the mixture the desired consistency.

M. E. CANEK.

Waterproof Paint for Plaster

To make waterproof paint for plaster get some mica plates, bleach them by fire, boil in hydrochloric acid, wash and dry and reduce to a fine powder; then mix with sufficient quantity of collodion to make the mixture run from the brush. Apply with ordinary paint brush.

F. L. ENGEL.

Paint for Fitting and Scraping

To make a paint for fitting and scraping, get some scarlet vermilion (powder) at a paint store. Melt a tablespoonful of lard and mix into the dry paint until like thick cream, and when cold it is just right. The vermilion is very fine and has no grit in it, so that the least touch of the mixture shows.

This is better than the tube paint, as it is mixed with animal oil, and will stand exposure to the air

for a year or more without drying; but the tube paint is mixed with vegetable oil and will soon harden on exposure to the air. Any colored paint powder can be used. To test for grit, take some between the thumb and forefinger. F. W. B.

Non-flaking Whitewash

To prepare whitewash for fences, buildings, shop interiors, etc., that will not flake and fall off, mix 1 part fine Portland cement with about 8 gallons whitewash. The cement binds the whitewash to the wood and makes a permanent covering which is unaffected by weather conditions. The small quantity of cement used and the constant stirring necessary to keep the whitewash in good condition for applying, prevents the cement hardening in lumps at the bottom of the pail, as might be expected. M. E. Canek.

Brilliant Whitewash

Use half a bushel unslaked lime; slake with warm water, cover it during the process to keep the steam; strain the liquid through a fine sieve or strainer; add a peck of salt, which previously has been well dissolved in warm water; add three pounds of ground rice boiled to a thin paste, and stir in boiling hot; add one-half pound of glue which has been previously dissolved over a slow fire, and add five gallons of hot water to the mixture; stir well and let it stand for a few days, covering up to keep out dirt. It should be put on hot. One pint of the mixture, properly applied, will cover a square yard. Small brushes are best. There is nothing that can compare with it for outside or inside work and it retains its brilliancy for many years.

MISCELLANEOUS RECEIPTS

The receipts in this book have been arranged in general groups or classes, as far as possible, so that the user frequently can locate the receipt desired without referring to the general index. This particular section, however, contains unrelated receipts which cannot be grouped under one general heading.

Lubricant for Small Oilstones

As a lubricant to use on an oilstone, for honing-out dies or other similar work, kerosene oil gives the best results, as it not only enables the stone to "take hold," but also keeps it clean and prevents it from filling up. C. F. Emerson.

Resurfacing Worn Oilstones

Grinding on an emery wheel will glaze the surface and destroy the cutting qualities of the stone. The method described in the following will restore the stone to as good a condition as when new. An old bastard file is laid on the bench, and a small quantity of oil and coarse emery placed on it. The stone is then rubbed back and forth over the file with a slight pressure until the surface of the stone is straight. A straightedge or scale may be used to test the surface. G. W. Nusbaum.

Preventing Oilstones from Glazing

The proper use of oil or water will prevent the particles of steel that are removed when sharpening tools from filling the surface of an oilstone, which is the cause of glazing. Oil should preferably be used

on fine-grained natural or artificial stones, because water is not thick enough to keep the steel out of the pores. Dirty oil should be removed from the stone after using, because if the oil dries the steel dust will be deposited in the surface of the stone. When using coarse-grained natural stones, plenty of water should be applied. Gasoline or ammonia will usually restore the cutting qualities of a stone that has become glazed or gummed, but if this treatment is not effective, the stone should be scoured with loose emery or a piece of sandpaper fastened to a flat board.

To Mend Broken Oilstones

A valuable oilstone can usually be saved when broken, even if there should be several pieces. The pieces must first be thoroughly cleaned and all oil driven from the fractured surfaces by heating on a hot iron plate. After the surfaces to be joined are properly prepared, they are well dusted with powdered shellac and again heated until the shellac is melted and flows well into the joints. The heating should be done on a smooth metal plate and the stone kept from the flame; otherwise it is likely to crack in other places; avoid overheating for the same reason. When the shellac has melted, the parts are pressed together and clamped until they have cooled. A joint so made often lasts as long as the stone, and if carefully made leaves the cutting surface smooth.

O. M. BECKER.

Drilling Holes in Glass

There are several methods of drilling holes in glass. For holes of medium and large size, use brass or copper tubing, having an outside diameter equal to

the size of hole required. Revolve the tube at a peripheral speed of about 100 feet per minute, and use carborundum (80 to 100 grit) and light machine oil between the end of the pipe and the glass. Insert the abrasive under the drill with a thin piece of soft wood so as to avoid scratching the glass. The glass should be supported by a felt or rubber cushion, not much larger than the hole to be drilled. If practicable, it is well to drill about halfway through and then turn the glass over and drill down to meet the first cut. Any fin that may be left in the hole can be removed with a round second-cut file wet with turpentine.

Use of Solid Drill for Glass

For comparatively small holes, a solid drill is often used for glass. Use steel rod or an old three-cornered file, grinding the end to a long tapering triangular shaped point. Grip the drill in a chuck and rotate rapidly. Use a mixture of turpentine and camphor as a lubricant. Holes up to 1/2 inch in diameter can be drilled in glass with a flat drill which has been hardened in sulphurous acid, a mixture of turpentine and camphor being used as a lubricant.

Ordinary twist drills are also used for drilling glass, the turpentine and camphor mixture being used as a lubricant. The glass is drilled about halfway through and then turned over so that the remaining depth may be drilled from the opposite side. No jig or other fixture is required for this purpose. When the work is turned over, the bottom of the hole will be clearly shown by a white spot, and by centering the drill on this spot, a clean hole can be produced. Blotting paper is sometimes placed

beneath the glass, while drilling, in order to provide an even support.

Etching Holes in Glass

A hole may be cut or etched through glass readily by using hydrofluoric acid. The acid should be applied in the same way as etching acid, using wax to surround the portion of the glass which is to be penetrated. Hydrofluoric acid is sold in wax bottles, as it cannot be kept in glass. It may be handled with a hard rubber dropper similar in construction to the ordinary glass medicine droppers.

S. W. GREEN.

Cutting Plate Glass

Sometimes it is necessary to cut plate glass so as to leave the edges smooth and straight. If this work is attempted with the aid of a diamond glass cutter and rule, the glass will break with a ragged edge. A method of overcoming this difficulty, which has been used in cutting plate glass as thick as 1/2 inch and with excellent results, is as follows: First obtain a good diamond glass cutter, and with this tool scratch the glass along the line on which it is to be cut, using any good straightedge to guide the diamond. In this connection it may be mentioned that the deeper the cut the more uniform the surfaces of the cut edge will be. After laying the glass on a cold surface with the cut side up, for which purpose a surface plate is very satisfactory, an iron or steel rod about 1/4 inch in diameter is heated to a dull red. This rod is then laid along the line scratched by the diamond point and pressed lightly against the glass. When held in position for from one to four

minutes—depending on the thickness of the glass—it will be found that the glass will crack along the line, leaving a uniform surface.

To Cut Glass Tubes

Saturate a cotton string in kerosene, wrap it around the glass tube where you wish to have it cut, set fire to the string, and when all parts are ablaze, plunge the glass in a pail of water. Give the top of the glass a light blow with a stick, and there will be an even break all around.

CHARLES SHERMAN.

Mounting Spirit Level Glass—1

The leveling glass of a level is generally fixed in a brass tube with plaster of paris. This method has been found to be satisfactory for all levels having an accuracy of about five seconds angular measurement to each one-tenth inch graduation. For finer levels, it is better to fix one end only with plaster of paris and the other with cork, because, if the glass is fixed rigidly at both ends with plaster of paris, there will be a strain on the level due to temperature changes, and, as the expansion of glass and brass is different, a slight inaccuracy is liable to result. It is also advisable to have an extra glass tube surrounding the leveling tube for very accurate levels, in order to provide insulation from the heat of the hand. A level of one minute angular measurement to one-tenth inch graduation is the most serviceable for general use. One having an accuracy of 30 seconds to one-tenth inch should be used on a floor free from vibration. Finer levels are used mostly on surveying and astronomical instruments.

Mounting Spirit Level Glass—2

A simple method of setting a spirit level glass is to use a small piece of putty to support each end temporarily. The plastic putty can be made to hold the glass in the required position, it being an easy matter to depress either end so that it will be parallel or level with the working surface of the leveling bar. When properly leveled up in this way plaster of paris is poured around the supporting ends of the glass and allowed to set. The glass will then be held permanently in place. J. H. BEEBEE.

Plaster of Paris

Plaster of paris is a calcined gypsum from which the water has been driven off by heat. Plaster of paris, when diluted with water into a thin paste, sets rapidly, and at the instant of setting, it expands or increases in bulk. This material is, therefore, used for making casts of statuary, etc., as it fills the forms perfectly. It is also used as a pattern material. Plaster of paris sets in from three to six minutes, but if, for any reason, it is desired to keep the mass plastic for a longer period, this may be done by adding a drop of glue to a five-gallon mixture. This will keep the plaster of paris soft for a couple of hours.

Citric acid will also delay the setting of plaster of paris for several hours. One ounce of citric acid will delay the setting of one hundred pounds of plaster of paris for two or three hours. The acid is dissolved in water before being mixed with the plaster.

Plaster of paris, when mixed with cold water, has an expansion of about 1/16 inch to the foot when hardening. If this expansion is undesirable, it may

be mixed with warm water or lime water, in which case the expansion is negligible. When mixing plaster of paris, water should not be poured on the plaster, but the plaster should be sprinkled into the required amount of water until it sets as a powder upon the surface of the water. Then it should be stirred quickly by hand until the mass attains the consistency of heavy cream, when it is ready for use.

Mixing Plaster of Paris

To mix gypsum or plaster of paris, so as to make a smooth cream, or thin dough, without lumps, do not pour the water on the plaster, but turn the latter gradually into the water, spreading it about in shaking it in, and avoid stirring until all the plaster has been added.

Concrete Mixtures

Concrete consists of a mixture of sand, gravel, or broken stone, and cement in various proportions. Water is added to this, which, when chemically combined with the cement, binds the whole mixture together into a solid mass having the characteristics of strong artificial stone. The amount of each ingredient is usually measured by volume, and the mixture is generally designated by stating the proportion of each ingredient in a given order, as "1:2:5," where the first figure indicates the proportion, by volume, of cement; the second, the proportion of sand; and the third, the proportion of stone or gravel; hence, 1:2:5 concrete contains one barrel of cement (usually Portland cement), two barrels of coarse sand, and five barrels of gravel or broken stone.

For water tanks and similar structures which are subjected to considerable pressure and are required to be water tight, mixtures rich in cement and composed of either 1:1:2 or 1:1 1/2:3 concrete are used. For reinforced floors, beams, columns and arches, as well as for machine foundations that are subjected to vibration, a 1:2:4 concrete is generally used. This composition is also employed when concrete is used under water. For ordinary machine foundations, retaining walls, bridge abutments, and piers in the air, a 1:2 1/2:5 concrete is satisfactory, and for ordinary foundations, heavy walls, etc a lean mixture of 1:3:6 concrete may be used.

To Strengthen Concrete

The Bureau of Standards recommends the use of a small quantity of calcium chloride in the mixing water of concrete in order to hasten the hardening of the concrete. Tests showed that the addition of calcium chloride to the mixing water up to 10 per cent by weight increases the strength from 30 to 100 per cent over that of concrete in which plain water is used, and that the best results are obtained when from 4 to 6 per cent of calcium chloride is used. While calcium chloride has no harmful effect upon the concrete, it does affect iron and steel, and therefore should not be used for reinforced concrete.

Waterproofing Concrete

A serious drawback to the general use of concrete for tanks, cisterns, house walls, cellars, etc., is its permeability to moisture. Several formulas for making concrete waterproof have been successfully used, but some of them are too expensive for general ap-

plication. One of the simplest, cheapest, and most effective is that developed by the U. S. Geological Survey. A heavy residual mineral oil of 0.93 specific gravity, mixed with Portland cement, makes it waterproof and does not weaken when the concrete consists of, say, cement, 1 part; sand, 3 parts; and oil, not more than 10 per cent, by weight, of the cement. Concrete mixed with oil requires about 50 per cent more time to set hard, and the compressive strength is slightly decreased, but not seriously. The bond or grip of oil concrete on steel is much decreased when plain bars are used, but formed bars, wire mesh, or expanded metal act as effectively in it as in ordinary concrete mixtures.

To Waterproof Leather

To waterproof leather and leave it soft and pliable, apply a mixture of 4 parts castor oil and 1 part raw India rubber, by weight. Heat the oil to 250 degrees F., then add the rubber, cut into small pieces. Gradually stir until the rubber is completely dissolved and then pour into a suitable vessel and let cool. If used on dark leather, add sufficient printer's ink to give the dark color. E. W. NORTON.

To Waterproof Cloth Tool Bags

To waterproof tool bags or cases made of duck or other cloth, either of the following formulas may be used:

Use 1/2 pound of alum and 2 ounces of saltpeter dissolved in 1 quart of water. Immerse the article to be waterproofed in this mixture for 40 minutes, and boil hard; then rinse in cold hard water, hang up and let dry thoroughly before using.

Melt 1/2 pound of paraffin wax and mix in 1 quart of gasoline. Immerse the article in this and wring out and spread out to dry. In a short time it is ready to use. E. W. NORTON.

Fireproofing Solution for Aprons, Etc.

Toolmakers' aprons, factory shades and other inflammable materials may be rendered fireproof by being treated with the following solution: To 1/2 pound tungstate of soda add 2 quarts of water, or enough to entirely dissolve it, and bottle up tightly. This stock solution is to be added to sufficient water required to soak the article in the proportion of one-fifth the above solution to the required water. After being soaked, hang the article up to dry. Fireproofing factory shades at windows near gas jets or the cloth aprons worn when working over a fire in hardening and tempering tools, etc., will often save bad fires or serious accidents. E. W. NORTON.

To Fireproof Wood in Shops

To protect the woodwork around or near a forge, apply three coats of 3 parts alum and 1 part copperas, dissolved in water. Apply hot, and only allow sufficient time between applications for the preparation to saturate the wood. Follow this with a fourth coat composed of solution of copperas made to the consistency of paint by mixing with fire clay. This treatment will not only render the wood fireproof but will preserve it for many times its ordinary life.

Another fireproofing mixture for the same purpose is composed of 3 parts ground wood ashes and 1 part boiled linseed oil. This is applied with a brush.

Still another fireproofing treatment consists of three applications of hot solution of phosphate of ammonia. The last two treatments require renewing at least once a year. E. W. NORTON.

To Extinguish an Oil Fire

As water is a poor weapon against oil or japan fires, pails of sand should be kept on hand in japanning rooms. Sawdust is also an excellent means for extinguishing fires. At first thought it might appear absurd to attempt to extinguish a fire by sprinkling sawdust upon it. As a matter of fact, however, sawdust is quite effective under certain conditions, if properly applied; and it is particularly well adapted for extinguishing small fires in oils and other inflammable liquids. This is due to the fact that the sawdust particles pack together too closely to allow air to penetrate the surface freely enough to actively support the combustion beneath. It is this characteristic feature of sawdust that gives it value as an extinguishing agent. It smothers the flames in the same manner as a blanket, by excluding the air.

Sawdust may be successfully used for extinguishing burning gasoline that has been spilled upon floors or on the ground; but it is of comparatively little value in the treatment of gasoline fires in large tanks, because it is almost impossible to spread the sawdust over the entire surface before some of it sinks to the bottom, exposing the surface at these points and allowing the liquid to re-ignite. It is far more useful in connection with liquids such as heavy oils, lacquer, japan, and melted wax, because it floats upon the surface of fluids of this type, and blankets them quite effectually.

Use of Sodium Bicarbonate and Sawdust

The value of sawdust as an extinguishing agent can be considerably increased by the addition of a certain proportion of bicarbonate of soda (generally known as "baking soda"). This substance, when exposed to heat, gives off carbon dioxide gas, which materially assists in preventing the access of air. A mixture composed of 10 pounds of bicarbonate to 1 bushel of sawdust has proved satisfactory, and tests have shown that by the use of this mixture fires may be extinguished more quickly and with a smaller amount of material than when sawdust is used alone. The character of sawdust appears to have little effect upon its fire-extinguishing properties. Wet and dry sawdusts, from both hard wood and soft wood, have been tried with equally effective results. The sawdust should not be too fine, and it should be applied as quickly as possible, so as to cover the entire surface of the liquid. The application may be most effectively made by the use of a broad, flat shovel.

Safeguarding Sawdust against Fire

As a precaution against fire in pattern-shops and other plants where dry sawdust collects in considerable quantities, it may sometimes be advisable to sprinkle sodium bicarbonate upon the sawdust piles at intervals. If a pile so treated were to become ignited, the bicarbonate would be of material assistance in checking the combustion.

Care of Belts

Saturate the belt with animal grease or fish oil once every month, removing any surplus. Before the

grease or oil is applied, the belt should be thoroughly cleaned. The pulley faces also should be cleaned and polished. It is not the rough surface that increases the frictional resistance, but the intimate contact between belt and pulley.

Belt Dressing—1

Melt a pound of beeswax in a gallon of neatsfoot oil by a gentle heat. The most convenient way to secure a good mixture is to melt the beeswax first, then add the oil slowly, stirring it constantly until it is thoroughly mixed. OSCAR E. PERRIGO.

Belt Dressing—2

The following mixture is a good belt dressing as well as an excellent anti-slip medium for hard-worked leather driving belts: Russian tallow, 1 ounce; best lard oil, 2 ounces; Venice turpentine, 16 ounces.

W. R. BOWERS.

Transmission Rope Dressing

A good transmission rope dressing is made by melting together 450 pounds of tallow, 33 pounds rosin, 150 pounds beeswax, 20 pounds pine tar, 14 pounds lampblack, and 15 pounds tobacco tin-foil. Pour the mixture in molds to make stock 2 1/2 inches in diameter, and 11 inches long, weighing about 3 pounds each. Use one for about 400 feet of one-inch rope.

HERMAN JONSON.

Wire Rope Grease

A mixture of 3/4 oil and 1/4 colophony (rosin), will be found to be a very good lubricant for wire ropes such as used on power transmitting and convey-

ing machinery, if applied warm. Boiled linseed oil also answers the same purpose when high speed is required.

MAX J. OCHES.

Fluxes for Steel Welding

In heating steel for welding, the tendency is for the surfaces to become oxidized, or covered with oxide of iron, which forms a scale when the hot iron comes into contact with the air. If this scale is not removed, it will cause a defective weld. Wrought iron can be heated to a high enough temperature to melt this oxide so that the latter is forced out from between the surfaces by the hammer blows; but when welding machine steel, and especially tool steel, a temperature high enough to melt the oxide would burn the steel, and it is necessary to use a *flux*. This is a substance, such as sand or borax, having a melting temperature below the welding temperature of the work, and it is sprinkled upon the heated ends when they have reached about a yellow heat.

The flux serves two purposes: It melts and covers the heated surfaces, thus protecting them from oxidation, and, when molten, aids in dissolving any oxide that may have formed, the oxide melting at a lower temperature when combined with the flux. Wrought iron can be welded in a clean, well-kept fire without using a flux of any kind, except when the material is very thin. The fluxes commonly used are fine, clean sand and borax. When borax is used, it will give better results if burned. This can be done by heating it in a crucible until reduced to the liquid state. It should then be poured onto a flat surface to form a sheet; when cold, it can easily be broken up and

pulverized. The borax powder can be used plain or it can be mixed with an equal quantity of fine clean sand and about 25 per cent of iron (not steel) filings. For tool steel, a flux made of 1 part of sal-ammoniac and 12 parts of borax is recommended.

Steel Welding Compound

A good compound for welding tool steel is made as follows: 41 1/2 parts boracic acid; 35 parts common salt; 20 parts ferrocyanide of potassium; 7 1/2 parts rosin; 4 parts carbonate of sodium. Heat the pieces to be welded to a light red heat and apply above compound, then heat to a strong yellow heat and the welding may be accomplished in the usual manner. Avoid breathing the poisonous fumes of this compound. A. A.

To Weld Spring Steel

An experienced blacksmith has used for years the following in welding steel springs. Just before the steel comes to a welding heat he places a small piece of Russian sheet iron—such as stove bodies are made of—on the joint; this melts and runs into the joint so that the weld is perfect. X. Y. Z.

Pulverizing Borax

To a two-gallon pail of boiling water add as much borax as will dissolve—12 to 15 pounds will dissolve in two gallons of water. Next set the pail in cold water, running water preferred. Stir contents vigorously, which will in a few minutes form into a thick mass; spread this out thin on some smooth surface, as tin, where it will soon dry to flakes which, when handled, will crumble to dust. Albert D. Knauel.

Iron or Steel?

To find out whether a piece is steel or iron, touch it with nitric acid, using a stick of wood, and then wash it with water. If iron, a light or azure stain will appear; if steel, the stain will be black.

J. M. MENEGUS.

Acid Test for Iron and Steel

A simple acid test for iron and steel is made as follows: The sample to be tested should be filed smooth or polished. Then place it in dilute nitric or sulphuric acid for from 15 to 20 hours; then wash and dry the sample. The best steel then has a frosty appearance; ordinary steel has a honeycombed appearance; and iron presents a fibrous structure in the direction in which it has been worked. A. A.

Steel Seasoning Process

Pieces of steel and also castings, if left standing a long time, will gradually settle to a more or less permanent state. This method of seasoning, however, is slow and usually impracticable as applied to manufacturing. An artificial seasoning process which is utilized in precision gage block manufacture, consists in subjecting the gages to alternate changes of heat and cold. A lot of the gages, contained in a wire basket, are immersed in a bath, the temperature of which is well below zero, this temperature being maintained automatically by a refrigerating apparatus. After the gages have come to the temperature of this cold bath, they are quickly transferred to a bath which is heated to about 220 degrees F. After heating thoroughly, the gages are again transferred

to the cold bath, and this successive heating and cooling is continued for several hours, which completes the artificial seasoning process.

Marking Polished Steel

A very handy way of marking polished steel for sizes, instructions, etc., is to keep a small oil can filled with turpentine with which to saturate a small piece of waste as needed; rub over the surface to be marked, and then do the marking with an indelible copying pencil, which will show up very plain.

ARTHUR MUNCH

To Write Black on Glass

To write black on glass or bright metal, use 1 to 2 parts of silicate of soda with 10 parts of India ink. Write with a steel pen. F. H. JACKSON.

Heat Losses from Bare Steam Pipes

The actual heat losses in a steam pipe depend upon the size of the pipe, its position, the nature of the pipe surface, and the velocity of the air surrounding the pipe. Horizontal steam pipes radiate heat more rapidly than vertical pipes, the reason for this being that the heated air surrounding a vertical pipe travels upward along the surface of the pipe, while with horizontal pipes the heated air rises immediately upon being heated, thus making room for cooler air, which is, in turn, heated. For all practical purposes, however, it is customary to assume a loss of 3 B. T. U. per square foot, per hour, for each degree F. difference in temperature between the steam in a bare steam pipe and the air surrounding the pipe, as previously mentioned.

A good grade of asbestos or similar pipe covering will reduce this loss at least 85 per cent. Tests made on an 8-inch standard steam pipe 60 feet long, carrying steam at from 109 to 117 pounds per square inch gage pressure, and surrounded by air at temperatures varying from 58 to 81 degrees F., showed that each square foot of bare pipe surface radiates approximately 2.706 B. T. U. per hour, per degree average difference of temperature between the steam in the pipe and the outside air.

Covering for Steam Pipes

To one barrel of lime use six barrels of sawdust. Slake the lime in an ordinary mortar bed, and when slaked mix in the sawdust, using enough mortar to make it of the consistency of mortar. Apply when the steam is on. The covering is adapted for steam pipes and boilers, more especially in sawmills and other places where a box can be built around the pipe so as to hold the mixture. THEODORE DISCH.

Making Wax Impressions

It often happens that it is required in the manufacture of goods to make a wax impression of a sample or model. To do this successfully, proceed as follows: Oil the surface of which the impression is to be made very slightly with a few drops of oil applied to a little waste. Then take common beeswax, melt it slowly, but do not boil it. Mix it with one or two tablespoonfuls of lampblack to half a tumbler of beeswax and stir the mixture. In order to make the wax impression show up clearly, take a fine hair brush and brush a little powdered graphite or rouge over the object on which the impression is to be made.

Die-sinkers' Impression Wax

Following are two receipts for die-sinkers' impression wax. In the first, the exact proportions of some of the ingredients are not given, but the maker can use his own judgment, gradually adding more of one than the other until the right consistency is obtained. 1. Beeswax, 6 parts; white wax, 1 part; a small quantity of cornstarch; sufficient Racine castor oil to make it of the desired consistency. Add stearine if too soft. 2. Another receipt is two parts of beeswax, and one part bayberry wax. Powdered chalk may be used to remove the stickiness of this wax.

C. W. Shelly.

Molds for Rubber Stamps

The following mixture is one which can be used for making molds for rubber stamps, special shapes of rubber, or for complicated or odd-shaped patterns of small size, as the work must be done within ten minutes: Plaster of paris, 5 pounds; French chalk, 2 pounds; china clay, 2 pounds; dextrin, 1/2 pound; mix with dextrin water, which is made by dissolving 1 pound of dextrin in one gallon of water. The surface takes a finish as smooth as glass if well rubbed. If an impression is to be made, the surface of the type or article to be impressed should be rubbed with a solution of kerosene and graphite.

Frank G. Sterling.

Silver-white Bronze

To prepare silver-white bronzing powder, melt together one ounce of bismuth and tin, adding one ounce of mercury. When cool, pulverize into a fine powder.

R. P. Perry.

Marking Valve Name-plates

Plates used to label steam or other valves are often located in semi-dark localities. Good plates may be made for this purpose by stamping the letters into a piece of brass, sand-blasting and oxidizing them and then filling the letters with a mixture of chalk and ammonia. Different colors of chalk may be used, and the letters show very plainly in a place where the light is dim. The chalk put in in this way will stand considerable handling before it is dislodged.

Gun-metal Finish on Aluminum

A gun-metal finish can be given aluminum by immersing it for from six to ten seconds in a cold solution of 12 parts of hydrochloric acid; 1 part of chloride of antimony; and 87 parts of distilled water. After that, thoroughly wash it in running water for several minutes, dry with heat, and lightly buff with a high-speed wheel. The color penetrates the metal, and its depth is governed by the length of time it is immersed. If immersed longer than ten seconds, the solution should be weakened, as hydrochloric acid "eats" the metal.

Satin Finish on Aluminum

The article should first be dipped in a caustic soda or caustic potash solution—potash preferred—then thoroughly washed in clear water and dipped in a bath of concentrated nitric acid, after which it should be thoroughly washed and dried in hot sawdust. The caustic solution should be prepared in a tank provided with a steam coil and should test with Baumé's hydrometer at anywhere between 20 and 30. The length of time an article should remain in the

caustic solution is a matter of judgment. The solution should attack the aluminum rapidly, and upon removing the article from the solution, the solution should boil furiously on the metal.

After washing, the articles should show a very black color, which turns to a silvery white finish upon dipping in the nitric acid. The best temperature for the caustic solution is at 200 degrees F., just below the boiling point. By the use of a steam coil the solution can be kept at an even temperature, and the strength of the solution can be maintained by adding small quantities of caustic from time to time. The temperature and strength of the solution are very important. The principal point to bear in mind in washing and drying is to dry without streaks, which is accomplished if the sawdust contains no pitch or rosin.

This finish can be improved by scratch-brushing the article before dipping, or by first dipping in the two solutions and then scratch-brushing and afterward dipping again. The scratch-brushing destroys the grain of the metal and reduces the possibility of the article drying with streaks. S. H. Sweet.

To Keep Steel Tools in Handles

To keep steel tools in their handles, fill the handle with powdered rosin and a little rotten stone. Heat the tang of the tool hot, and then push it down hard into the handle; when it is cold it will be firmly set.

M. E. Howe.

Fastening Hammer to Handle

A method of fastening a hammer to its handle so that it will not come off is to first secure the handle

to the hammer by means of three iron wedges set in the usual H form, and then boil the hammer and handle in linseed oil for several hours. A hammer thus treated has been in fairly constant use for thirty years without showing the slightest sign of coming off the handle. The handle is made of good hickory.

Durability of Well-plunger Leathers

The durability of the leather cups that are used on deep well plungers as packing, is greatly increased if they are dipped in hot paraffin before being used. When treated in this manner they do not harden and crack as soon as otherwise. JOHN B. SPERRY.

Recharging Permanent Magnets

To recharge a permanent magnet, attach to a direct-current electromagnet. Allow the two magnets to remain together for about 45 minutes and strike the permanent magnet light blows with a hammer every few minutes. The "molecules" of the steel must all lie in the same direction in order for the magnet to retain its magnetism. The light blows struck with the hammer while the current is flowing sets up a vibration in the steel which enables the molecules to adjust their position so that the magnetism is retained after the magnet to be charged is disconnected from the electromagnet. GEORGE H. HAMILTON.

To Punch Hard Rubber

To punch hard rubber successfully, heat the punch and die, or the material. The blanks usually curl or wrinkle into almost every conceivable shape in the operation of cutting. To straighten and bring them

back to their original outline, allow the punchings to drop into a pan of hot water. The action of the hot water causes the curled parts to return to their former flat shape, the same as before passing through the die.

L. C. CARR.

To Cut Cork

In cutting cork, the knife should be kept greased. Where, however, the desired piece is symmetrical about one axis, and of circular cross-section, it may best be roughed with a greasy knife and then ground to profile with a coarse emery wheel. Cork pen-holders are made in this way. Where many pieces are to be cut out of sheet cork, it is advisable to use a band knife, against which there is kept pressed a block of grease.

ROBERT GRIMSHAW.

Strength of Seasoned Wood

There have been differences of opinion as to whether kiln-dried wood is as strong as wood that has been air-dried. In order to determine the relative properties, the Forest Products Laboratory of the United States Forest Service at Madison, Wis., made some 150,000 comparative strength tests on specimens from twenty-eight different common species of wood. The results of these experiments showed conclusively that good kiln-drying and good air-drying have the same effect upon the strength of wood.

The belief that kiln-drying produces stronger wood than air-drying is usually the result of failure to consider differences in moisture content. The moisture content of wood, on leaving the kiln, is usually from 2 to 6 per cent lower than that of thoroughly air-dried stock. Since wood increases in strength

with loss of moisture, higher strength values may be obtained from kiln-dried than from air-dried wood; but this difference in strength has no practical significance, since eventually a piece of wood will come to approximately the same moisture condition, whether it is kiln-dried or air-dried.

Coal Weight per Cubic Foot

The weight of coal per cubic foot or the volume of coal per ton varies according to the size of the lumps of coal, and also, according to the quality. On the average, one cubic foot of anthracite coal weighs from 55 to 65 pounds, and one ton (2240 pounds) of anthracite coal occupies a space of from 34 to 41 cubic feet. One cubic foot of bituminous coal weighs from 50 to 55 pounds, and one ton of bituminous coal occupies a space of from 41 to 45 cubic feet.

To Cleanse Mercury

To cleanse mercury from grease or dirt, first put a 10 per cent solution of nitric acid in an iron ladle, and then the mercury to be cleaned; place over a blacksmith's forge until the nitric acid boils. The dirt will then rise to the top, and leave the mercury perfectly clean in the bottom. Care must be used not to let the mercury boil, as the fumes are very poisonous. H. C.

Strop Paste for Keen Edge Tools

An excellent strop paste for edging razors or other keen-edge tools is a mixture of levigated oxide of tin, 1 ounce; powdered oxalic acid, 1/4 ounce; powdered gum, 20 grains. Mix to a paste with water, spread evenly over, and work well into the strop with some

smooth surface. The rough side of the strop gives best results. E. W. BOWEN.

Re-inking Time-clock Ribbons

For re-inking time-clock ribbons we use the following receipt for black: 1 ounce aniline black; 15 ounces pure grain alcohol; 15 ounces concentrated glycerin. Dissolve the aniline black in the alcohol and then add the glycerin. For blue, use Prussian blue, and for red, use red lead instead of the aniline black. This ink is also good for rubber stamp pads.

Anti-freezing Solution

A solution for water jackets on gas engines that will not freeze at any temperature above 20 degrees below zero may be made by combining 100 parts of water by weight with 75 parts of carbonate potash and 50 parts of glycerin. This solution is non-corrosive and will remain perfectly liquid at all temperatures above its congealing point.

File Resharpening

There are several processes for resharpening files by the use of acid solutions. The acid must not be permitted to attack the files unduly. To prevent this, it is advisable to make a few tests or trials to determine the length of time the files should be immersed in order to obtain the desired results, before proceeding with the work on a quantity basis.

Cleaning Solution for Files

First clean the files by immersing them in a solution of caustic soda and boiling water for a period

of from ten to fifteen minutes. This solution is made by dissolving 100 grains of caustic soda in one gallon of water. The same proportions should be used if a larger quantity of the solution is required. Two gallons will ordinarily be sufficient for cleaning 100 files of the sizes generally employed in the shop.

Use of Nitric and Sulphuric Acids

After the cleansing treatment, the files are placed in an acid bath. This bath is made by adding twelve parts of water (by volume) to a solution consisting of one part nitric acid, one part fuming (Nordhausen) sulphuric acid, and one-third part concentrated sulphuric acid. These parts are measured by volume and not by weight. The files, when placed in the acid solution, should not overlap and should be arranged so that the solution will reach all surfaces. It is preferable first to suspend the files in the tank and then add the acid solution. The files should be allowed to remain in the solution from five to ten minutes, the exact time being determined by experiment.

Sulphuric-acid Process

Experience in sharpening between 2000 and 3000 files in acid solutions led the writer to select the following method as the one giving the best results. The first step is to remove all grease and dirt from the files. This may be done by soaking the files a few hours in gasoline and then brushing them with a wire brush, or by boiling them a few minutes in a 10 or 15 per cent water solution of caustic soda, and then drying and brushing them. It is essential that the files be thoroughly cleaned, as the acid cannot

reach the steel through grease or oil. The clean files are placed in an enamel basin, a lead-lined box, or a "Pyrex" glass baking dish. Short pieces of wire or nails are placed between the files to separate them sufficiently to permit the acid to reach all the surfaces that are to be sharpened.

After covering the files with water, sulphuric acid is slowly poured into the tank until a solution that is about 25 per cent acid is obtained. As the acid combines with the water, a considerable amount of heat is generated which causes the acid to act more rapidly. Files having fine teeth may be sharpened in from three to five minutes, while files with coarse teeth generally require from five to twenty minutes. A second batch of files can be treated in the same solution by adding a little sulphuric acid. After two or three batches of files have been treated, however, it is usually necessary either to heat the solution or make a new one.

Use of Nitric and Hydrochloric Acids

Another process consists of immersing the files in a warm aqueous solution of nitric acid and hydrochloric acid, consisting preferably of about equal parts of the acids and of water. This solution should be kept at a constant temperature. After the files have been treated with the acid solution, they should be washed in lime water or some other alkaline solution, and then wiped with oil. A. EYLES.

Adding Acid to Water

Caution must be exercised in mixing sulphuric acid and water. Always pour the acid into the water slowly; never pour water on the acid, as an explosion

may result, the same as when babbitt is poured into a wet box or mold. In both cases the explosion is caused by the sudden generation of steam. Commercial hydrochloric acid diluted with about 10 per cent water and heated to near the boiling point can be used instead of sulphuric-acid solution. The diluted hydrochloric acid has the advantage of being safer to handle.

As soon as the files are removed from the acid solution, they are washed in running water and dried rapidly by heating. After drying, they may be dipped in gasoline containing about 5 per cent paraffin or engine oil. The gasoline evaporates, leaving a thin coat of oil on the files. A. N. Clark.

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698 WLW CINC

700 SEATTLE

701 CHICAGO WGN

703 ATALANTA

703 ½

705

804 KOA [illegible]

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